



THE STATE OF
TECHNOLOGY

What will it take for us to compete in the high-tech arena?

Joseph Schumpeter, the renowned Harvard economist, saw a normal, healthy economy as not one in equilibrium, but one that is constantly being disrupted by technological innovation. It is Schumpeter who scenically talked of the “perennial waves of creative destruction” that sweep the American economy – new technologies and innovations continually pushing out and supplanting older ones in an ongoing and irreversible process. In Schumpeter’s time, railroads, electricity and automobiles were among the new technologies that swept the world and changed the lives of all. More recently, the ubiquitous spread of the microcomputer, rise of the Internet and the decoding of the human genome bode to be ranked of equal or greater importance.

While Schumpeter’s process of “creative destruction” referred to the dynamism of early 20th century America, his observations remain relevant today in Hampton Roads. The region’s economic growth is critically dependent upon innovation and upgrading the technological base established during the last years of the 20th century. Indeed, the future prosperity of Hampton Roads depends jointly upon: (1) spurring the production of engineering and scientific innovations by private firms; (2) building a strong university research and development infrastructure; and, (3) vastly accelerating the process of technology transfer and commercialization to and from federal laboratories and installations in the region. The latter two points are critical.

Hampton Roads does not yet have the strong university research and development infrastructure that characterizes virtually every other economically vibrant area in the United States. It is not by accident that areas such as Boston, Austin, the Silicon Valley, Salt Lake City and Seattle are located in the midst of powerful university-based research, development, commercialization and entrepreneurial enterprises. Hampton Roads has the budding beginnings of such a university complex, but it has not yet come to fruition. Equally important, however, is the fact that Hampton Roads, while technologically rich in terms of the large size of its federally owned engineering and scientific infrastructure, has not yet found the ways and means to transfer the impact of those federal activities to its private sector. Hampton Roads ranks among the top four regions nationally in terms of the proportion of its population trained as scientists and engineers. The problem – but also the opportunity – is that most of these scientists and engineers are employed in federal laboratories and installations, and often their activities are only tangentially related to the dynamic, private-sector entrepreneurial process that generates new firms, patents, technology transfer and commercialization of ideas. That is, these scientists and engineers are doing many interesting things of great technical sophistication, but the spinoffs to private-sector activity have been disappointingly small, and even when they have occurred, they often have been exported to other cities and regions.

A Realistic View of Where the Region Stands

It is quite unlikely that Hampton Roads will soon become another Silicon Valley, as some of the more aggressive advocates of the region dream. A realistic assessment reveals that conditions in Hampton Roads are much different from those in Silicon Valley. For example, one-third of all the generated venture capital in the country goes to Silicon Valley. In the first quarter of 2000, a total of \$17.2 billion was invested nationally, with \$6.1 billion in support of Silicon Valley enterprises. Here in Hampton Roads, the availability of venture capital, whether from local or outside sources, is comparatively in an embryonic stage. Further, Hampton Roads does not boast the likes of a Stanford University or a Massachusetts Institute of Technology with their long histories of launching high-tech firms. True, this past year Old Dominion University recorded more than \$55 million in research grants and contracts, not an inconsiderable sum, and the College of William and Mary, the Virginia Institute of Marine Science and Eastern

Virginia Medical School together approximately duplicated that sum. Nonetheless, even these amounts combined would not place Hampton Roads’ higher education institutions among the top 50 nationally.

What’s Required for a Technologically Vibrant Region?

For a region to be successful technologically it requires a combination of factors so ably summarized in *Forbes* magazine: “The best places to do business are technology hubs where entrepreneurs can feed off top knowledge institutions and where business costs are low.” An infrastructure supportive of innovation is required and its elements include:

- recognized research facilities whether university, federal or industry based;
- a large university known for its comprehensive and advanced research and development programs;
- a trained workforce on both the professional and technician level;
- sources of venture capital to support entrepreneurial start-up companies as well as technological expansion of established companies;
- a culture that encourages risk and innovation;
- low business costs (though not necessarily the lowest taxes);
- encouragement of government-industry-academic partnerships to develop high-tech incubators;
- physical infrastructure to nurture technology companies, especially those deploying broadband telecommunications systems;
- good transportation links, preferably including a hub airport; and
- lifelong learning to adjust skill sets.

Research Facilities

The major research facilities in Hampton Roads consist of: (1) NASA Langley Research Center; (2) the Jefferson Laboratory; (3) the Joint Training, Analysis and Simulation Center; (4) NASA’s Wallops Island site (though technically it is not located in Hampton Roads); (5) Newport News Shipbuilding; (5) Eastern Virginia Medical School; and, (6) university-based laboratories, primarily at Old Dominion University and the College of William and Mary. Together, these agencies employ approximately 8,000 full-time engineers and scientists and undertake at least \$500 million in research and development expenditures annually. **If all of these facilities were merged, and if they were pursuing common goals, and if they were focused upon private-sector innovation and commercialization, then they would constitute a “top 10” research and development establishment nationally.** Alas, there are too many “ifs” here. These facilities are not merged, do not pursue common research and development agendas, and often are not focused on private-sector innovative and entrepreneurial activities.

NASA LANGLEY RESEARCH CENTER

Of these facilities, NASA Langley Research Center easily is the largest and, despite NASA budget reductions, still maintains a large and impressive research and development program. Its importance — and its vulnerability — merit focused attention. NASA Langley employs approximately 3,800 scientific and technical staff and has an annual of some \$600 million. As such, it is a bulwark of the economic development of Hampton Roads. Were NASA Langley to disappear, it would plunge the region into a near depression.

Recently, a significant change in Langley funding occurred, resulting in the phasing out (in fiscal year 2000) of the high-speed research and advanced subsonic technology programs. This is not good news, for it potentially removes Hampton Roads from the aeronautics process that will refine existing large passenger airliners and produce the next generation of airliners. Thus far, the number of scientific and technical staff has been only modestly impacted. However, NASA Langley's funding (for fiscal year 2001) is again under attack in Washington. **Although the overall proposed cuts are relatively small compared to last year's (see Table 1), they will nevertheless, if sustained, undermine basic aeronautics research and development programs that could be vital to Langley's long-term future.**

Unquestionably, NASA Langley is critical to the growth of technology in Hampton Roads, even though the number of private-sector spinoffs has never been as large as many would have liked. Accordingly, it must have grassroots support throughout the year, not just when a crisis develops during a budget cycle. One group that has been steadfast in its efforts to focus attention in Washington (and nationwide) on the state of aeronautics funding at NASA is the NASA Aeronautics Support Team. This community-based communication and lobbying organization has been stressing the vulnerabilities of funding at Langley and the importance to the region of maintaining a stable or increasing research and development financial base.

JEFFERSON LABORATORY

The Jefferson Laboratory is a significant, and as of yet substantially untapped, source of private-sector engineering and scientific vitality for the Hampton Roads region. The very nature of the Jefferson Laboratory is difficult for most people to understand, because its primary focus is high-level, fundamental nuclear physics research that is concerned with the nature of matter itself. Yet, the Laboratory, which functions as an arm of the U.S. Department of Energy, has tremendous potential for private-sector spinoffs and entrepreneurial activities. The Laboratory's powerful, tunable free-electron laser, the newest of its facilities, could generate a plethora of commercial applications that range from making metals stronger and more corrosion-resistant to destroying cancer cells. Eight universities and 12 corporations, including DuPont and 3M, have begun research programs to develop products and processes that could result in significant technology transfer, commercialization and private-sector expansion.

Although the Jefferson Laboratory's technical staff and funding are not expected to increase significantly over the next few years (see Table 1), its potential, particularly as a significant research laboratory for the region, has never been brighter.

The Laboratory's budget is expected to exceed \$116 million in 2001, by itself a significant economic stimulus to the region. The salient question, however, is whether this research activity will spawn university-based spinoffs and private-sector commercialization.

TABLE 1

Funding and Staffing at NASA Langley and Jefferson Laboratory

	1998	1999	2000	2001
Funding (\$ millions)				
NASA Langley	686.0	632.0	567.0	646.0
Jefferson Laboratory	71.7	74.6	95.5	116.4
TOTAL	794.4	706.6	662.5	762.4
Workforce				
NASA Langley				
Civil Service (50 percent Scientists & Eng.)	2,241	2,328	2,382	2,387
Contractors	1,576	1,482	1,420	1,420
Jefferson Laboratory				
Scientists	98	107	107	107
Engineers	64	80	80	80
Technicians	198	216	216	216
TOTALS	4,177	4,213	4,213	4,210

Source: NASA Langley Research Center and the Jefferson Laboratory

JTASC

Also worthy of mention is the Joint Training, Analysis and Simulation Center (JTASC) in Suffolk. Little known to some, JTASC probably is the single most sophisticated modeling and simulation center in the world. It is here that the Department of Defense, and the U.S. Navy in particular, stage extremely large-scale simulations of military and political events. More than 1,000 people may participate in a single game or simulation. The level of analysis is quite high and the engineering and computer science skills called upon are considerable.

The relevant JTASC technology question insofar as Hampton Roads is concerned is this: Can this knowledge and these tools be exported to the private sector and commercialized as salable products, perhaps that appear in shrink-wrapped software packages? Attempting to do this is Old Dominion University's Virginia Modeling, Analysis and Simulation Center (VMASC). VMASC has accumulated \$18 million in contracts and has attracted more than two dozen sponsors from the private sector. VMASC's activities include modeling the Port of Hampton Roads and improving the routing of school buses. **It is too early to tell if a modeling and simulation industry as such will spring up in Suffolk around I-664. What can be said is that the potential is tremendous and, in contrast to many other technology initiatives, there are only a few serious competitors nationally.**

VASCIC

With shipbuilding in Newport News dating back to the late 19th century, it is only fitting that the development of the nation's next generation of aircraft carriers be centered at Newport News Shipbuilding. Beginning with the CVN77, which is expected to be completed in 2008, aircraft carriers must incorporate the latest technological advances in a timely and cost-effective manner. Providing a foundation for the research and development directed at this goal will be the Virginia Advanced Shipbuilding and Carrier Integration Center (VASCIC). A joint venture of the Commonwealth of Virginia, the City of Newport News and Newport News Shipbuilding, VASCIC is responsible for ensuring that the Navy's future aircraft carriers will be able to respond to changing combat and cost requirements. Virginia has committed \$98 million to VASCIC, \$58 million of which is earmarked for construction and up to \$40 million for operations. Operations that are to begin in mid-2001 will include, but not be limited to, the administration, management, testing, training and research as required to integrate advanced shipboard systems. **The goal of VASCIC is to create 600 full-time high-tech, engineering-related jobs in the shipbuilding industry, primarily in Hampton Roads.** This build-up will begin in mid-2001 and continue at a steady rate until 2005 when the addition of personnel will level off.

This latest example of high-tech growth in Hampton Roads should bring benefits in the form of an improved employment market for technologists and a focal point for attracting new technology firms. There is no question that the presence of VASCIC must be viewed as a major development, one having a significant long-run impact on the region in general, and on Newport News in particular.

THE UNIVERSITIES

The recently formed University Research and Development Consortium consists of the region's eight institutions of higher learning and two of the federal laboratories (NASA Langley and the Jefferson Laboratory). Its mission is to consolidate efforts to increase the research and development capacity of the universities and laboratories that will result in attracting more technology-related businesses. The eight universities (including EVMS) account for about \$125 million of research contracts and grants on an annual basis. This is a considerable and impressive sum; however, it is uncoordinated and remarkably lacking in focus. Since each of these university entities is independent, each pursues its own priorities. Indeed, an immediate challenge is to better understand the nature and extent of research currently being performed throughout the region. Regardless, despite the \$125 million research total, the region usually fails to achieve what knowledgeable researchers conceive of as being "critical mass" in its research efforts because these efforts are spread across so many different topics and institutions. There is little or no coordination of effort and startlingly little communication among engineers and scientists at the various institutions. This may suit the individual institutions, but it is sub-optimal insofar as the Hampton Roads region is concerned.

That said, there does exist one shining example of research collaboration among institutions of higher education. It is the Applied Research Center (ARC) in Newport News, which is connected to the Jefferson Laboratory. ARC is an example of a consortium of universities engaged in research and development for advanced materials and laser technology, as well as collaborating on projects with industry partners. Common research topics often are pursued and a common location encour-

ages cross-fertilization of ideas and communication. The two largest participants in ARC are Old Dominion University and the College of William and Mary, but other institutions, notably Christopher Newport University, Norfolk State University and Hampton University, also participate. This is an instructive example, for ARC would not have appeared except for the encouragement and resources provided by the Jefferson Laboratory. Universities, like most other technology entities, pay attention to resources and appropriate incentives stimulate them to reorder their research priorities. This is a lesson that should not be lost when the region considers how it will accomplish similar ends in the future.

Making an impact in the technology community is Virginia's Center for Innovative Technology (CIT). In 1999 alone, it provided leadership for the initiation of 23 projects in Hampton Roads with more than \$1.5 million in total funding. Most projects are university-connected.

A Closer Look at University Technology Facilities and Activities

None of the region's four-year colleges or universities undertakes sufficient externally funded research and development activity to place it in the top 100 nationally, although Old Dominion University recorded more than \$55 million in external research and contracts in 1999-2000. This total places Old Dominion among the top 175 universities nationally, and its rank has been rising rapidly. Nonetheless, it is a paltry sum compared to the more than \$1 billion of research activity annually done by Johns Hopkins University, which leads the pack nationally. Unquestionably, Hampton Roads needs a vital, first-class, nationally recognized research complex that can attract students of an entrepreneurial bent, train them and launch them into the Hampton Roads workforce. The goal must be to form the nuclei of the needed high-tech innovative enterprises that can induce venture capitalists and others to increase their investments in the region. Other significant technology activities include:

- **The Virginia Institute of Marine Science at the College of William and Mary** – one of the largest coastal and estuarine science institutions in the world. State-of-the-art laboratories, a fleet of research vessels and a first-class marine library support the highly regarded research programs in coastal management, fisheries, estuarine science and environmental science.
- **Old Dominion University's Multidisciplinary Parallel-Vector Computer Center** – home to a Sun Microsystems HPC 10000 supercomputer. This is a highly significant regional tool for research and must be available to industry and research centers for solving large-scale, complex equations and problems. The HPC 10000 is the most powerful computer at a Virginia university and is among the 350 most powerful supercomputers in the world. Old Dominion gradually has built an electrical engineering, computer science, physics and chemistry faculty who are experts in high-speed computing and computation. Such individuals are the building blocks for future entrepreneurial spinoffs.
- **The Enterprise Centers at Old Dominion University** – coupled with the Bank of America Entrepreneurial Center. These centers form partnerships with industry, giving the university's faculty and students the opportunity to work on "real-world" problems. For example, Old Dominion's College of Engineering and Technology operates the high-speed wind tunnel at NASA Langley and will soon be sending commercial satellites into space at Wallops Island.
- **Old Dominion University's IITPro** – the largest university producer of Microsoft Certified Systems Engineers in Virginia. The school's Information Technology Professional Program (IITPro) offers certificates in database management and Web development in Virginia Beach, Hampton and Northern Virginia.
- **Eastern Virginia Medical School** – research programs through the Jones Institute for Reproductive Medicine, the Leonard R. Strelitz Diabetes Institutes and the Center for Pediatric Research. EVMS typically attracts \$25-30 million in

extramural research funding annually and recently received a prestigious \$25 million grant from the Gates Foundation.

- **Virginia Electronic Commerce Technology Center (VECTEC) at Christopher Newport University** – a partnership with Virginia's Center for Innovative Technology, Newport News Shipbuilding and Bell Atlantic. VECTEC advances the uses of electronic commerce technologies in the region's small businesses and governmental organizations. With projected sales of more than \$28 billion in 2000, e-commerce is an area of burgeoning importance regionally and nationally and, in fitting with Gov. Jim Gilmore's goals for the Commonwealth, Old Dominion University has initiated both bachelor's and master's degree programs in the discipline.
- **Hampton Roads Smart Region Initiative** – an electronic platform featuring a state-of-the-art Web site as well as Internet tools that facilitate communication and collaboration among educational, business and governmental communities. The Hampton Roads Partnership has responsibility for this endeavor, which could be a significant factor in upgrading the "entrepreneurial culture" in the region.

A Closer Look at Private-Sector Technology

Transferring the products of NASA research to the private sector is the goal of the Hampton Roads Technology Incubator, which was created in 1998 as an operating division of the Hampton Roads Technology Council (HRTC). By mid-2000, the Incubator had accumulated 12 client companies with 32 full-time employees. The number of companies is expected to increase to 15 by 2001. HRTC has plans for the creation of three or more additional incubators to be located in South Hampton Roads and Williamsburg. For several years, the City of Norfolk has promoted a biotech incubator intended to house early-stage biotech start-up companies. The BioVenture Forum is also active in the promotion of biotech innovation.

In the private sector, large firms direct their research and development efforts toward computer hardware, information services and nuclear systems, whereas the small to medium companies tend to focus their efforts toward manufacturing, engineering services, defense and aerospace software engineering, and electronics and simulation/training. In Hampton Roads, (see Table 2) the majority of companies – over 80 percent – have fewer than 100 employees, but companies with more than 1,000 employees – a mere 1 percent of the total – account for more than 60 percent of the total technology employment.

Venture capital is necessary to accelerate the growth of innovative companies. The greatest amount of venture capital nationally has been invested in software, telecommunication and networking, and associated equipment. The areas receiving significantly less attention are industrial, biotechnology and semi-conductors. Hence, to capture a larger share of the venture capital funds available, the region needs to promote research and development in those areas most likely to attract venture capital. The Virginia Venture Capital Forum, a four-year-old organization, brings together investors, bankers, venture capitalists and entrepreneurs. **Currently, there are more than five venture capital firms active in Hampton Roads. It is estimated that their total investment in regional technology companies was \$3-5 million in 1999 and will be about \$5-10 million in 2000.** Capital venture companies like Envest not only invest capital in fledgling companies, but partner with them to help manage their growth. The addition of venture capital and incubators to the region is a strategic element to encourage entrepreneurs to innovate and take risks.

TABLE 2
Private Technology Companies in Hampton Roads

	1996	1998	Percent of all firms 1996/1998
Number of Technology Firms	346	552	1.1/2.0
Technical Employment	47,093	54,788	7.5/8.0
Earnings of Technology (Direct)	\$1.6B	\$1.91	11.0 / 11.0

Source: Center for Regional Analysis, George Mason University

What Remains to Be Done?

Most of the support pieces required to make Hampton Roads a respectable national technology hub currently exist or could be created. True, the region's federal laboratories and installations heretofore have not exhibited a strong interest either in technology commercialization or in supporting and cultivating technology development in Hampton Roads, per se. Nonetheless, the potential is there and threats of federal budget cuts may cause these laboratories to place a higher value on their relationships with regional universities, firms and technology organizations. Similarly, it is true that the region lacks a single, large research university, though all of the institutions combined would merit designation in the top 100. The problem is convincing these institutions to coordinate their efforts, and thereby create critical mass, on research and development topics that clearly would benefit the region. And, it goes without saying that the regional legislative delegation should place a very high priority on increased funding for technology-based research and development activity at the region's public universities. The payoff to such investments will not come immediately, but the experience of other regions strongly suggests that it is the surest way to change a region's relative prosperity over a decade or more.

Candor requires the observation that what conceivably could be accomplished, however, has not been accomplished in the technology arena in Hampton Roads. As often is the case, technology policies in Hampton Roads have suffered from lack of unity and lack of prioritization. The time-honored bromide "United we stand and divided we fall" is a valid statement for the future of technology in Hampton Roads. A plethora of organizations and agencies exists in the region, and each provides some service to the technology community. One need only look at the "Technology ScoreCard" to know this is true. This compilation by the Hampton Roads Technology Council (HRTC) in 1998 lists 33 organizations focusing on some aspect of the region's technological base. The sheer number of organizations creates confusion.

The Hampton Roads Partnership comes as close as any organization in legitimately representing the interests of the entire Hampton Roads region. The Partnership completed a region-wide planning process in 1999 that resulted in the adoption of a Technology Strategic Plan that, if followed, would lead to a more rational and consolidated/coordinated regional technology approach. The Partnership has commissioned HRTC to implement this plan to the extent possible. Of course, HRTC neither can force federal laboratories to focus more attention on commercialization and technology transfer nor can it force universities to adopt common research agendas that make sense for Hampton Roads. And, it goes without saying that HRTC cannot force the regional legislative delegation to make sharp increases in the research and development funding of the area's colleges and universities. Nonetheless, it can promote discussion, rational interchange, sharing, cooperation and prioritization, and it has the ability to do so without reference to city labels and loyalties that too often in the past have prevented the region from uniting behind sensible initiatives that emerge from a particular city. What is good for Newport News in technology ultimately will be good for Norfolk, and vice versa. The region must think and act regionally if it is to succeed in the technology arena of the 21st century.

A prime example is the aforementioned University Research and Development Consortium, whose development has been stimulated by the Hampton Roads Partnership. It is an initiative with great merit and should be championed. It should develop a common research agenda for Hampton Roads universities in order to develop critical research mass. Natural points of common interest might include research topics related to the Applied Research Center; modeling and simulation topics related to the Virginia Modeling, Analysis and Simulation Center; and, topics related to the ocean and environment. In addition, the Consortium should find ways for all of the institutions to utilize unique research assets, such as Old Dominion University's super-computer.

Another necessary element leading to the technological success of the region is the willingness of the Commonwealth and local governments to provide, through partnerships, taxes and other incentives, a business climate that will facilitate innovation and entrepreneurial risk-taking.

The continued addition of technology incubators throughout the region will help provide the culture that encourages innovation

and risk. **Further, if Hampton Roads is to become a significant high-tech competitor and a nationally reputable technology star, it must find ways to increase the venture capital flowing into the region. Incubators and venture capital work hand-in-hand in promoting an entrepreneurial culture.** These efforts must be supported by the universities, government and private industry if they are to make a significant impact. These are not challenges for the region to undertake lightly and will require a great deal of cooperation and trust by all parties.