COLORADO BUSINESS REVIEW

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Professor Arnoldo Majerfeld (center) of the ECE Department at the University of Colorado at Boulder works with students in the Semiconductor Nanostructures Fabrication Clean Room to make quantum well structures for a new piezoelectric laser.

The Building of Nano Mountain

Louis Hornyak

One of the founders of the Colorado Nanotech Initiative, Feliciano Conde, coined the moniker "Nano Mountain" in jest. He said, "Instead of a Silicon Valley, how about Nano Mountain?" Although nanotechnology is the next industrial revolution according to pundits in Washington, D.C., just what is the landscape for nano here in the 1.61 trillion nanometer-high state? Is it feasible to start building a Nano Mountain? According to *Small Times* magazine, the official reputable source for small-tech news, "it is a matter of when, not if, Colorado breaks into the top ten," of states leading the nation in nanotechnology. Colorado is currently rated 13th, behind California, Massachusetts, New Mexico, New York, Texas, and seven other states based on parameters such as investment dollars, research activity, infrastructure, and others factors. Colorado is well poised to not only break into the top ten, but become one of the top five states in the country. Nanotechnology is the manipulation, control, and integration of materials, structures, and devices at the nanoscale. A nanometer (nm) is one-billionth of a meter.

How do we make this happen? According to Mark Modzelewski, the executive director of the NanoBusiness Alliance, nanotechnology necessitates new types of partnerships that require academia, business, economic development entities, and government to work together. This is due, in part, to the high barrier of entry required to participate in nano; it's not exactly a project one can accomplish in a garage. Starting with academia, Colorado's research institutions and national labs have been involved in nanoscience and nanotechnology R&D for more than 15 years. This is good. Nanoscience and nanotechnology curricula are making headway at CU, CSU, DU, the Colorado School of Mines, and community colleges such as Arapahoe and Red Rocks. National laboratories such as the National Institute of Standards and Technology and the National Renewable Energy Laboratory have well-developed nanotechnology research programs and are beginning to expand public outreach.

Colorado already possesses one of the best-educated workforces in the nation. University infrastructure consisting of user facilities and expertise, coupled with a highly trained workforce, is attractive to business. The first piece of the partnership, needing only some tuning, is already in place. According to the recent Milken Institute technology rankings (2004 State Technology and Science Index), Massachusetts, California, and Colorado are in the best position to take advantage of the knowledge-based economy. This bodes well for nanotechnology.

With respect to business, Colorado was recently rated in the top ten in terms of nanotechnology company density by *Small Times.* Companies such as ZettaCore, Inc. and ITN Energy Systems are beginning to make their mark in the state. Large corporations, including Intel in Colorado Springs and Lockheed Martin, are already on board to varying degrees. Economic development groups—the Jefferson Economic Council, for example—have spearheaded nanotechnology and its organization in the Denver metro region. The service-provider industry of

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HIGH-VALUE JOBS AND WAGE POTENTIAL OF TECHNOLOGY-BASED AND SUSTAINABLE INDUSTRIES

- Employment in the photonics industry is estimated to grow by roughly 20% annually until 2011 (*Electronic Engineering Times* 2001).
- The 2002 average annual wages for the state's photonics industry were $57,689 (Colorado Photonics Industry Association).
- The world's environmental market is expected to grow by 91% from 2000 to 2010 (*Engineer* magazine).
- The global market for nanotechnology industry is expected to reach $1 trillion by 2015 (Phillip Bond, Undersecretary of Commerce for Technology, May 2003).
- The job creation that will result from nanotechnology industry growth is estimated to be 7 million positions (Phillip Bond, Undersecretary of Commerce for Technology, May 2003).
- The average annual wage for the nano-tech industry in 2002 was estimated to be $63,000 (Global Emerging Technology Institute).

Colorado's Environmental Industry Primed for International Opportunities

Laura Levesque

Driven by its "wild west" mindset, Colorado has always been on the forefront of adventurous endeavors and innovative projects. This is true now more than ever in Colorado's environmental sector. The approximately 2,500 environmental firms that exist in the state generate $2.2 billion in state revenue, including $452 million from exports. Colorado is already internationally recognized as a leader in clean technologies; environmental management systems; and world-class technologies, products, and services. Colorado will continue to globally expand its environmental expertise, which is already deemed as one of the state's most prolific exports.

Colorado's environmental dominance is driven by its environmental companies, government agencies, academic institutions, and environmental associations. Each entity plays an important role in Colorado's environmental cluster, which is largely concentrated along the Denver-Boulder corridor. The geographic proximity of these environmental entities allows for greater synergies, such as sharing information, technologies, and resources, and collaborating on projects. Colorado's environmental cluster provides participants with a competitive advantage, further facilitating domestic growth and promoting stronger commitment to the global arena.

Several of Colorado's environmental companies already enjoy success in international markets. The trio of environmental engineering companies—CH2M HILL, MWH, and Tetra Tech EMI—have won contracts all over the world, including projects with the 2008 Beijing Olympics, the rebuilding of Iraq, and reengineering power transmission lines in Nigeria. The Hach Company has also achieved international success in the environmental monitoring market. Moreover, several environmental consulting firms, such as QUEST Management International, Transnational Associates, and 2MS, have an important international client base. These are Colorado's global pioneers, which have introduced the international community to Colorado's impressive environmental capabilities.

Also achieving international acclaim are Colorado's environmental think tanks. Among the two most prominent are the Colorado School of Mines and the National Renewable Energy Laboratory (NREL). The Colorado School of Mines has become world renowned for its environmentally conscious mining techniques and other environmental practices. Mining experts from around the world consult with the School of Mines on projects within their own countries. The NREL represents another prominent think tank producing unique environmental solutions that benefit not only our nation but also influence the rest of the world.

Innovation has a spill-over effect onto the myriad of Colorado's entrepreneurs. Over the 10-year span of 1988 to 1998, Colorado placed first in the nation for the number of Phase I and II grants received from the EPA's Small Business Innovation Research (SBIR) project. A total of 24% of these awards were bestowed on Colorado environmental entrepreneurs. These accolades are granted to "small high-tech firms to help develop and commercialize cutting-edge environmental technologies." One of the key elements of the program is to "improve the international competitiveness of the U.S. technology industry." This incentive has greatly encouraged entrepreneurial spirit and positioned new environmental products for international growth.

Other programs specific to the state of Colorado encourage international growth within the environmental industry. Organizations such as the Colorado Environmental Business Alliance (CEBA) and the U.S. Department of Commerce sponsor environment-specific trade missions to Vietnam, Malaysia, and China. The Denver Mayor's Office of Economic Development and International Trade has proved its dedication in further supporting these pursuits by opening trade offices in the United Kingdom and in Shanghai, China. This gives Colorado greater exposure in the European Union, and in China, one of the world's largest growth markets. Moreover, Colorado has welcomed environmental delegations from around the world and is recommended by the International Trade Administration as a destination for visiting environmental specialists.

Colorado is primed to capture an even greater share of international environmental opportunities. The global environmental market is currently estimated at $560 billion, and various analysts project growth rates anywhere from 10% to 34% over the next two decades. Significant growth potential exists in Eastern Europe as these countries strive to comply with E.U. environmental regulations. China is increasing the number of environmental rehabilitation projects and proactive environmental planning. The Middle East will recover from environmental impact after the Iraq War. The international community recognizes the importance of environmental preservation and sustainability and seeks solutions in accomplishing these goals. Colorado has demonstrated its capabilities in providing world-class environmental technologies, products, and services. The strength of our environmental sector will command Colorado greater prosperity and influence in the worldwide environmental arena.

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Investment Forums—The First Step on the Road to Entrepreneurial Success

Rob Wamsley

Investment forums provide an efficient way for companies seeking capital and for investors looking for innovative companies to meet face-to-face. For business owners, the chance to participate in an investment forum is an exciting opportunity to share the vision of what their company could be with an infusion of cash. A successful pitch can launch a company to the next level.

On the other side of the podium, investors in the audience are interested in seeing as many quality companies as they can during a forum. Like consumers in a buying mood who are watching an hour of five-minute infomercials about dynamic companies, investors pay close attention, sometimes wanting to fast-forward to the next deal and sometimes wanting to rewind for an instant replay of a tempting offer.

Business owners find investment forums beneficial because of the unique opportunity to be surrounded by a room full of investors giving their undivided attention. Likewise, the forums provide investors with an efficient way to see multiple deals. It is important for the entrepreneurs seeking venture capital for the first time to understand that the forum gives them a chance to pique the interest of investors, but that they will not be leaving the forum with a check in hand. More analysis will follow before a contract can be signed.

To be successful, investment forums require preparation on the part of the organizer and participants. Forum planners match entrepreneurs' industry focus and deal size with the investors' interests. Presenters need to prepare written material, practice their presentation, and know what to expect on the day of the event. Investors are advised to do homework on companies before seeing the presentation.

Investment forums can be industry or regionally focused. Presenters are usually given 10 minutes (strictly enforced) to showcase their company and talents. Before owners even make it to center stage they have already gone through a selection process and typically receive coaching on their presentation. Investors can learn more about companies during a question-and-answer period at the end of each presentation or the forum may be structured to have entrepreneurs staff booths at the end of the session. Unless approached for a deal, companies seldom learn the identity of the investors in the audience.

The Colorado Environmental Business Alliance (CEBA) holds an annual Sustainable Business Investment Forum open to companies seeking early-stage funding ranging from $500,000 to about $5,000,000. In April 2004 CEBA received more than 50 business plans from companies interested in participating in this event. Business plans undergo the University of Colorado Business Advancement Center's (CUBAC) review process. During this process, feedback from two private-sector consultants on the center's advisory board is used to refine the business plans. Once revised, the plans are again reviewed and discussed by the full advisory board. Polished business plans are screened, and the most suitable companies are selected to participate in the forum.

Two weeks before the forum each company is required to give a practice dry-run presentation to CEBA reviewers. This process helps streamline the presentations and assures that critical topics of interest are covered in order to optimize the company's opportunity. It is not unusual for practice presentations to take twice the allotted time and still be missing key information. Valuable advice about what can be cut and what needs to be added is provided, and the companies are encouraged to practice their presentation to make sure that it flows and fits within the time limit.

The 2004 investment forum included five companies, some with deals under $1,000,000 that are suitable for angel investors and others with deals up to $3,000,000 that may be of interest to venture capitalists. Eleven investors, comprising both angel and venture capital investors, were in the audience.

Feedback was given to each entrepreneur from investors in the audience regardless of whether the investors intend to further pursue the company. This feedback is particularly important to business owners because it is specific to them and comes directly from their target audience. It is useful for future presentations and can also assist owners in strengthening their business strategy.

Investment forums are an important component for a healthy entrepreneurial environment. Events like the CEBA Investment Forum help promote small and medium-size business and keep Colorado ranked as one of the top locations for innovative companies.

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THE BUILDING OF NANO MOUNTAIN, CONTINUED FROM PAGE 1

law firms and the investment community will be ready when nano gains more momentum.

An important ingredient of the partnership—government—is also coming along. Despite Colorado's budgetary woes, the state appointed Chris Shapard as director of Biosciences and Emerging Technologies in the Colorado Office of Economic Development and International Trade. The Colorado Legislature overwhelmingly passed senate joint resolution SJR04-025 titled "The Importance of a Comprehensive Nanotechnology Initiative for Colorado." The CU Business Advancement Center and the Colorado Nanotech Initiative have submitted a proposal to the Denver Region Economic Development Administration of the U.S. Department of Commerce to write the strategic plan for nanotechnology for the state. Our Congressional delegation has been briefed and will be working on a line-item appropriations bill this year to enhance nanotech in this state. President Bush signed the "21st Century Nanotechnology R&D Act" authorization bill last December. Colorado needs to leverage its nanotech assets to ensure we get a piece of that federal pie.

The first "Colorado Nano/Micro Technology Summit" at the National Institute of Standards and Technology in Boulder on May 24 will go a long way toward bringing academia, business, and government to the table. The Colorado Nanotech Initiative has done its part in bringing awareness to the state over the past year and will serve as a nanoscience/ nanotechnology clearinghouse for the public, academic, business, and government communities. However, it is now time for decision makers in academia, business, and government to make the next move. Nanotechnology is the next industrial revolution. Colorado cannot afford to "wait and see." We need to plan now for the future. Niches are being filled across the country. High-quality jobs are at stake. Nanotechnology is not a separate industry sector, but an interdisciplinary enabling technology that crosses all industry sectors. It enables photonics, aerospace, energy, telecom, information, materials, electronics and others, and it will affect every product made. Nano Mountain here we come.

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On the Horizon

The 2004 Colorado Photonics Directory

Julie Arnett and Brendan Hickey

Much has been made of Colorado's high-tech industry, which is among the strongest in the nation. One sector that has helped lead the way for high tech is photonics. According to data gathered for the 2002 Colorado photonics directory, the industry comprised 242 organizations and employed more than 36,000 people. However, in the past two years Colorado has suffered through its worst economic downturn since the Great Depression. This recession has been particularly hard on the high-tech sector of the state, including the photonics industry. According to Colorado Photonics Industry Association President Silvia Mioc, these last few years in the photonics industry have been tumultuous. Many companies have gone out of business, but there have also been a number of new start-ups. The soon-to-be-published fourth edition of the Colorado photonics industry directory will examine how the cluster faired during this slump, and look at the future of the industry. In addition to providing a list of local photonics companies, the directory will highlight employment and wage data for the industry, and will discuss results from the annual survey of photonics companies. A preliminary look at these results follows.

Industry Composition

The products and services of Colorado photonics companies can be divided into five categories: end-product manufacturing, component manufacturing, supplier/process support, business support, and research/education. Preliminary survey results show more than 56% of the companies manufacture end products and roughly 50% manufacture components. Just over 58% stated that they provide process support or supplies to the photonics industry, while approximately 26% offer business support services. Nearly 35% of the survey respondents indicated that they provide research or education services.

Industry Collaboration

Not only is photonics an industry in and of itself, but it is also an enabling technology used in a variety of different industries. For this reason, an effort was made to identify industries that photonics companies are currently working with. Aerospace was the most commonly cited. Other industries indicated as having close ties to photonics were defense/homeland security, electronics, biotechnology (devices), and telecommunications.

Areas of Application

The companies were analyzed further to find what specific application areas would use the products and services they provide. Not surprisingly, aerospace/aviation topped this list. Other major areas of application include test and measurement, defense and homeland security, medical/biomedical devices, laboratory research, and biotechnology.

Geographic Distribution

Finally, the directory examined the geographic distribution of the photonics sector. Companies appear to be dispersed throughout the state of Colorado, but the industry is concentrated primarily along the Front Range. In all, there are companies in 24 cities and 15 counties. The state's largest photonics cluster is in Boulder, with 38% of Colorado's photonics companies located in the city. The next largest clusters are in Longmont and Colorado Springs, both with 13% of the state's photonics companies.

Complete survey results, and industry analysis will be unveiled in August during the annual meeting of the International Society of Optical Engineering (SPIE). Co-sponsored by the Colorado Photonics Industry Association (CPIA), this event is expected to draw 5,500 attendees to Denver. Some of the sessions at this year's conference will discuss the use of photonics in areas such as remote sensing and space technology, signal and image processing and sensors, nanotechnology and organic materials, and radiation technologies. CPIA President Silvia Mioc invites you to attend one or more of the six free seminars the association will be offering during SPIE's annual meeting. For more information, visit www.spie.org/conferences/am or www.coloradophotonics.org.

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