# ‘Supplying' Workforce Needs:
# The Creation of The National Center for Supply Chain Technology Education

ABSTRACT

Supply Chain Technologies include software, hardware and productivity processes which enable goods to be manufactured, assembled, and distributed effectively. Companies effectively using these types of supply chain technologies will require highly-trained technicians in Information Technology, electronics engineering technology, manufacturing technology, automation and control technology, and geospatial technologies. However, knowledge in just one technology area is not sufficient to be hired and valued by 21st Century Warehouse employers. Supply Chain Technology is interdisciplinary requiring technology education programs that integrate installing, operating, supporting, and maintaining this new technology. The National Science Foundation has invested in the creation of a National Center for Supply Chain Technology Education to increase the supply of highly qualified supply chain technicians by 20,000, over four years, to meet the growing national need across the private and public supply chains. This paper discusses the supply chain technologies, 21st century warehouses, the emerging occupation of Supply Chain Technicians, existing education and training models, as well as the composition and goals of The National Center for Supply Chain Technology Education.

Corresponding author:
Kevin J. Fleming
Norco College
2001 Third Street
Norco, CA 92860
(951) 739-7880
Fax: (951) 739-7805
kevin.fleming@norcocollege.edu

Co-author:
Ned D. Young, Ph.D.
Sinclair Community College
444 W. Third St.
Dayton, OH 45402
(937) 512-2759
Fax: (937) 512-2125
ned.young@sinclair.edu

**What is Supply Chain Technology?**

Supply chain *management* involves the interplay between high technology and sound business management practices to improve the competitiveness of corporations and the effectiveness of government operations. Supply chain *technologies* enable supply chains. These technologies are used in a plethora of industries including: 1) food processing to ensure the food supply is safe and efficiently distributed, 2) pharmaceutical product storage and distribution via secure refrigerated warehouses, 3) hospital delivery rooms where RFID tags are attached to new born babies to protect against mothers nursing and taking home the wrong child, 4) seaports, railroads, and transportation hubs to move and track smart containers, 5) U.S. Department of Defense and other public sector agencies to ensure goods are acquired, moved and distributed efficiently and effectively, and 6) 21st Century warehouses to manage the movement and storage of large volumes of products and data.

"Supply chain software and technology is more powerful than ever, but the key is using it to its full potential (Shackett, 2010)." Slone, Dittman, and Mentzer (2011) point out that "Technology is always critical, but the real key is making sure you choose the *right* supply chain technology and successfully implement it. Improperly understood or implemented, technology can cause severe damage rather than improvement." Furthermore, Slone, Dittman, and Mentzer (2011) identify four categories of supply chain technologies currently used in business:

| Technology Category | Description |
|---|---|
| Software | Includes IT systems for activities such as forecasting, transportation, warehousing, inventory management, collaboration, etc. |
| e-business technologies | Includes such technologies as automatic ship notices, electronic data interchange, web portals, electronic invoicing and payment tied to shipping, etc. |
| Visibility and productivity | Consists of technologies such as advanced bar codes, radio frequency identification (RFID), voice and light picking |

| | |
|---|---|
| | systems, event management, etc. |
| Process advances | Includes process advances applied to the entire end to end supply chain, such as Lean, Six Sigma, collaborative planning forecasting and replenishment, etc. |

Intermec Technologies Corporation (2007) lists the following top ten technologies impacting supply chain operations spanning production, distribution, retail and remote service:

1. Comprehensive connectivity – from 802.11 wireless LAN technologies, cellular networks, Bluetooth
2. Voice and GPS communication integrated into rugged computers
3. Speech recognition
4. Digital imaging
5. Portable printing
6. 2D & other bar coding advances
7. RFID
8. Real time locating system
9. Remote management
10. Wireless and device security

**The 21st Century Warehouse**

"In the 21st century, more companies are recognizing that warehousing is a strategic business consideration, so they are viewing warehouse operations as an opportunity to gain significant competitive advantage" (Shacklett, 2011). The 21st Century warehouse is a modern technological marvel that is vital to the economic success of global business and the public sector. Kahn, et. al. (2010), Patterson, et. al. (2004.), Shacklett (2011), and Singh, et. al. (2007) highlight the following integrative technologies deployed in a 21st Century warehouse:

- Mobile robotic automation
- Moveable, programmable shelving units
- Robotic order fulfillment
- Unmanned robotic forklifts
- Hydrogen fuel cell forklifts
- Manned forklifts with onboard computers
- Internal wireless infrastructure
- Web-based warehouse management systems with graphical display dashboards
- Cloud-based information technologies

- Bluetooth connectivity
- Geospatial systems (RFID and GPS, satellite uplink/downlink)

Companies effectively using these types of supply chain technologies will require more technicians in Information Technology, electronics engineering technology, manufacturing technology, automation and control technology, and geospatial technologies. Knowledge in just one technology area is not sufficient to be hired and valued by 21st Century Warehouse employers. Just understanding Mechatronics, for example, without the RFID and GPS knowledge, not only puts one at a disadvantage for hiring but a technician would also be unable to operate and maintain unmanned forklifts, geospatial tagging systems, etc. Supply Chain Technology is interdisciplinary. To be most effective, the technologies must be **integrated** into an intelligent supply chain (Kahn, et. al. 2010). Similarly, technicians installing, operating, supporting, and maintaining this technology must be educated both within their specific disciplines and across these supply chain technologies focusing on this integration of tools to fulfill business strategy. Thus, its corresponding education and training programs must be deeply integrated in its inception, as well.

**The need for a Supply Chain Technician Workforce**

Private sector supply chain technology involves technicians in three general stages: (1) extracting and refining high quality raw materials, (2) manufacturing and producing products, and (3) distributing the finished products through a global network. Public sector supply chain technology involves agencies (defense, environmental protection, homeland security, etc.) obtaining and deploying materiel (equipment, materials, weapon systems, food, water, etc.) for the public good. For example, the U.S. Defense supply chain requires substantial numbers of contractor technicians for materiel solution analysis, technology development, engineering and

manufacturing development, production and deployment, and operations and support (Dahmann and Kelley, 2009). While the scope of the private and public sector supply chain process is immense, the core of its activities is enabled by STEM-based technology at all levels: geospatial technology (RFID, GIS/GPS), information systems (cyber security, warehouse information systems, modeling and simulation, data warehousing), operations technology (manufacturing, product lifecycle management, performance-based logistics), and automation and control technology (sensors, robotics, lights-out warehouse technologies).

The supply chain technician workforce, already at 11.3 million people, is projected to significantly grow in the future (EMSI, 2008b). In contrast with other industries, such as manufacturing where the workforce is shrinking, the supply chain workforce will expand over the next decade. For example:

- Supply chain technology jobs will grow 5% nationally from 2008-2018 (EMSI 2008c).
- The top 10 states with supply chain technology jobs in 2018 (in descending order) will be: California, Texas, Florida, New York, Illinois, Pennsylvania, Ohio, Georgia, New Jersey, and Tennessee.
- States with the largest projected growth are: California (9.85%), Texas (9.27%), Florida (5.63%), New York (5.61%), and Illinois (5.36%).
- The supply chain workforce in the California Inland Empire of Riverside and San Bernardino counties is projected to increase by 23% (EMSI, 2008b).
- The U.S. Defense Department has 125,879 military supply chain technology personnel working with 52,171 contractors nationwide. Defense Secretary Robert Gates announced plans to hire 20,000 additional acquisition professionals by 2015 (Castelli, 2009).

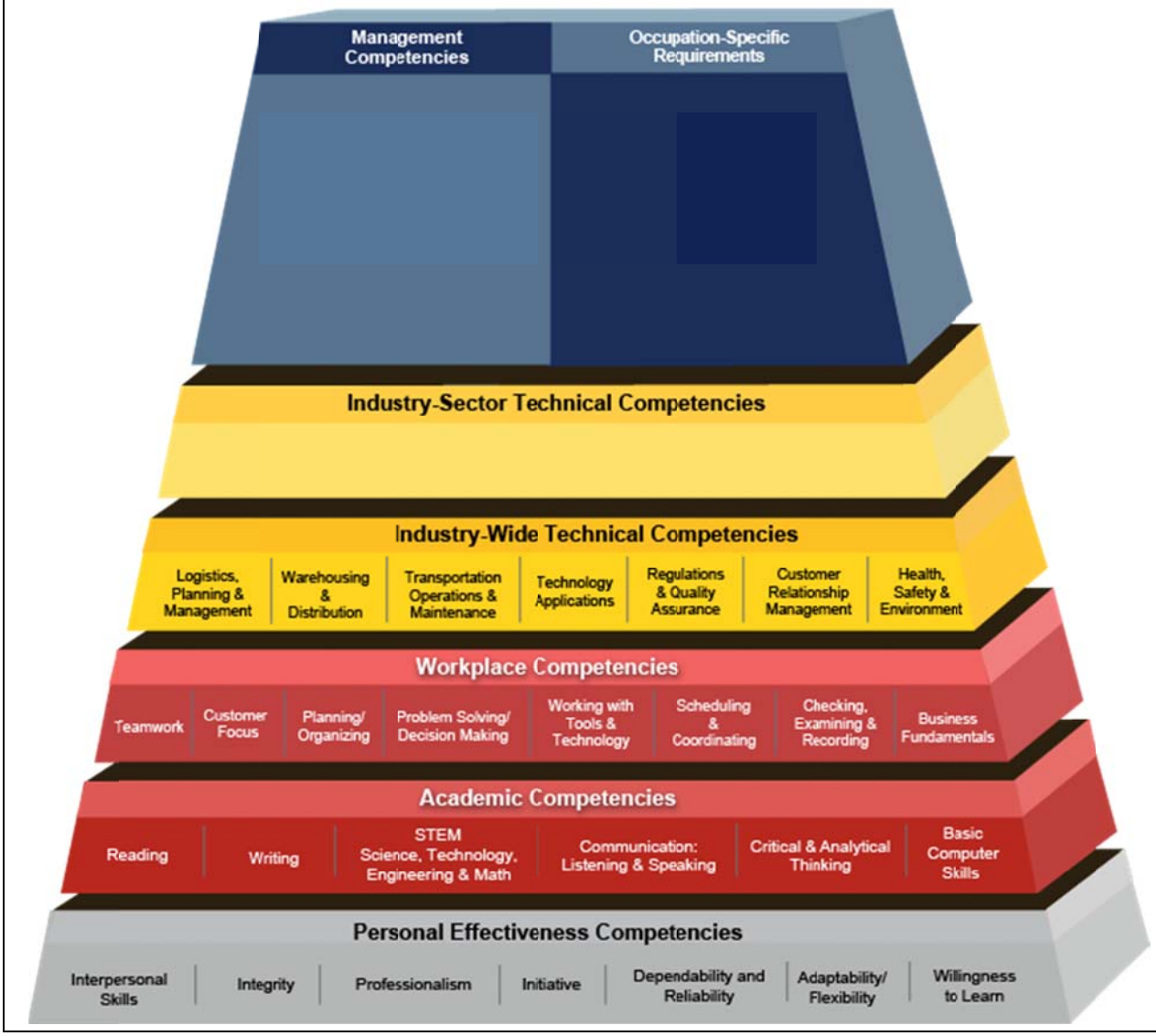
Researchers have demonstrated that companies with well-run logistics operations and effective supply chains outperform other companies in the national business environment (CSCMP, 2009). Given that business is the economic engine of the national economy, and the critical relationship of supply chain technology to business performance, maintaining the critical national supply chain infrastructure and educating the current and future technician workforce is essential to the economic health of the United States.

**Creating Educational Programs for Supply Chain Technology**

According to the Supply Chain Council (2011), there are numerous problems to defining and marketing supply chain occupations to students: 1) On a national level, most students in college do not realize there are careers and programs of study until their sophomore or junior year, 2) Secondary school counselors do not realize supply chain is a field of study and career, 3) There is no common industry definition of supply chain careers, and 4) The supply and demand of supply chain talent is not aligned. As a result, many supply chain graduates are unprepared for day one success in their new jobs (Supply Chain Council, 2011). To address these challenges, The National Center for Supply Chain Technology Education will focus on educating technicians for the supply chain technologies used in 21st Century warehouses.

The Transportation, Distribution, and Logistics Competency Model developed by the U.S. Department of Labor (2008) will be a fundamental source of the competencies for supply chain technicians:

**Transportation, Distribution, and Logistics Competency Model developed by the U.S. Department of Labor**




Within the Industry-Wide Technical Competencies in the U.S. Department of Labor model, shown above, the Technology Application competencies include those shown in the following table:

**Technology Application Competencies**
***(Source: US Department of Labor)***

Maintaining awareness of technological advances and applying appropriate technology to transportation, distribution, and logistics (TDL) processes.

**Critical Work Functions**

- Stays informed of technological advances that impact TDL activities
- Awareness of the benefits associated with implementing new technologies
- Application or use of various technologies that impact TDL activities

**Technical Content Areas**

- **Information Systems**
  - Geographic Information Systems (GIS)
  - Electronic Data Interchange (EDI)
  - Global Logistics Systems (GLS)
  - Intelligent Transportation Systems (ITS)
  - Advanced Traveler Information Systems (ATIS)
  - Transportation Management Systems (TMS)
  - Warehouse Management Systems (WMS)
  - Vehicle Monitoring Systems (VMS)
- **Technology**
  - Radio Frequency Identification (RFID)
  - AutoID Technologies
  - Materials handling technologies (e.g., voice-directed order picking technology)

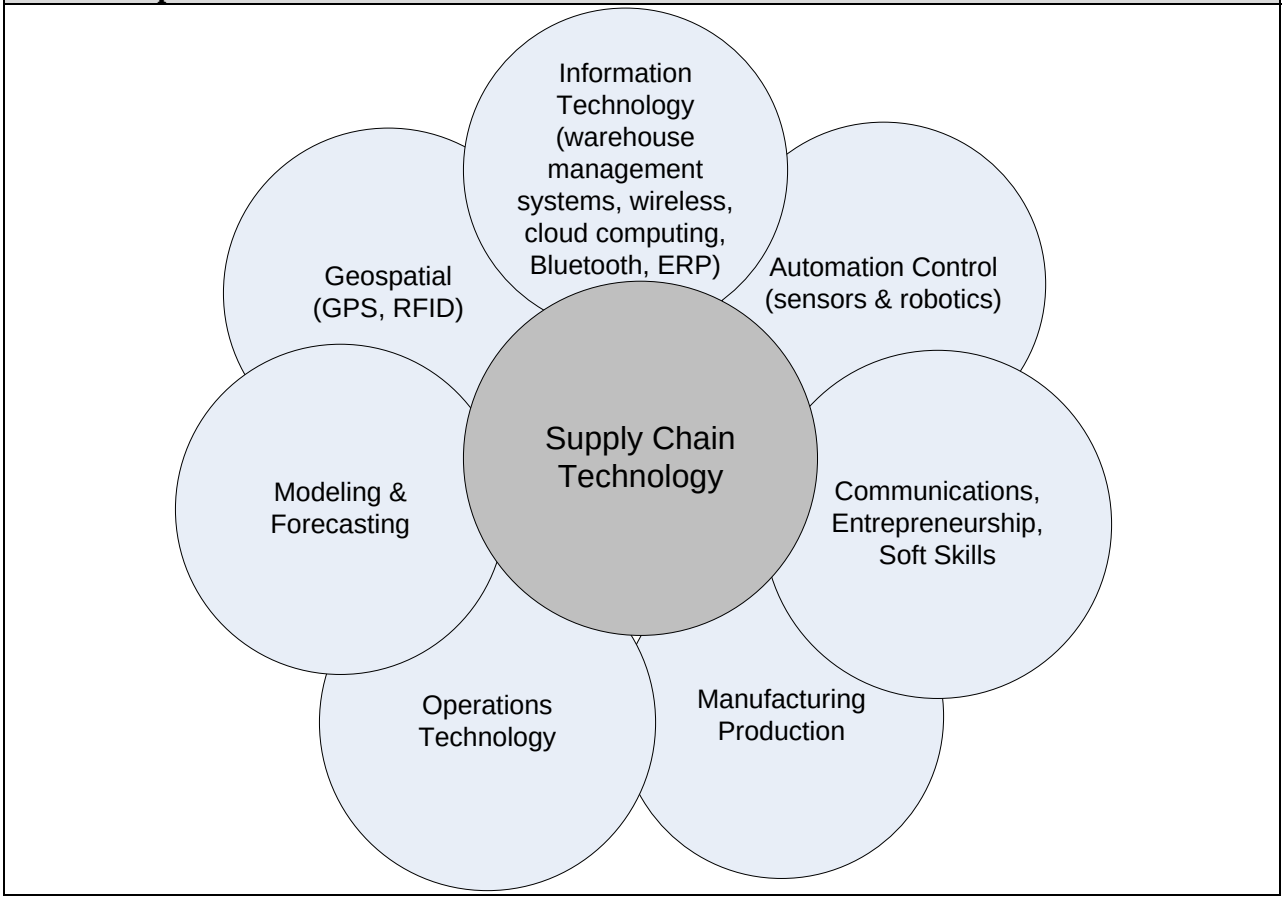
Sinclair Community College, under contract with the Ohio Department of Education, created the career pathway in supply chain *management* and the related competencies with an emphasis in the business technologies. This effort culminated with the Ohio Department of Education adopting and publishing the pathway and competencies for the State of Ohio (Ohio Department of Education, 2011). The National Center project team will use the Ohio Career Field Technical Content Standards Process to research and document the competencies for supply chain *technology* and the technical competencies required of technicians that install, operate, support, and maintain the technology. This new effort will be correlated with other existing business-related competencies identified by the U.S. Department of Labor Transportation, Distribution & Logistics Competency Model; the U.S. Department of Labor Advanced Manufacturing Competency Model; the Association for Operations Management

Supply Chain Manager Competency Model; the National Career Technical Education Foundation Transportation, Distribution and Logistics Career Cluster; the Manufacturing Skill Standards Council Logistics certification and the U.S. Department of Defense Core Logistics Competencies and Proficiencies.

While the National Center for Supply Chain Technology Education will focus on educating technicians, there also must be an infusion of soft skills and entrepreneurship throughout the model curriculum and supply chain technician pathways. Nearly 21.5 million entrepreneurs are the sole employee of their own firm, and the Transportation, Distribution and Logistics sector is not an exception (www.sba.gov). Van Sickle (2008) researched the value of entrepreneurship education at community colleges and reported that students were being better prepared for economic/job uncertainty and were better prepared to compete in the global economy.

The Venn diagram (next page) illustrates the relationship among the technical and non-technical areas which comprise Supply Chain Technology Education. Interpersonal communication, technical communication, entrepreneurship, and soft skills (work ethic, time management, problem-solving skills, etc.) are vital for successful Supply Chain Technicians. As noted by Dave Rost (2011) the Senior Operations Manager at Cardinal Health, his organization looks specifically for initiative and communication skills in their newly employed technicians.

**The National Center for Supply Chain Technology Education will integrate technical skills with entrepreneurial and soft skills.**




## A Focus on Problem-Based Learning

As with many disciplines, technology not only changes the focus of the work, but how the work is performed. This is especially true in 21st Century warehouses where sophisticated warehouse management systems are revolutionizing the industry (Cole, 2008). Hoffman (2006) points out that the integration of supply chain technologies is a key for effective management of the estimated 400,000 warehouses across North America. Brown and Campbell (1999) found that technological change has increased the skill demand for organizations and has required and supported new work practices. They suggest that case studies have:

> *". . . also documented that new technology changes the way work is done and organizations function. In particular, the introduction of microelectronics technology has involved new ways of producing services and products that change their nature (e.g., quality, variety, and customization as well as new products and services) and improve delivery (e.g., timeliness, flexibility, and customer service) rather than simply producing more of the same things more efficiently"* (Brown & Campbell, 1999)

Changes in supply chain technologies have moved rapidly, over the last two decades, and have migrated the organizational workforce from more manual type labor (e.g. sorters, package handlers, forklift operators, line supervisors) to technicians requiring higher level job skills associated with installation, support, maintenance, and upgrading of photo sensors, automated storage and retrieval systems (ASRS), RFID and wireless transmitters/receivers, robotic automation, information technology and database, graphical display dashboards, programmable logic controllers, and conveyer systems. The number of skilled technicians required to maintain and support these advanced technologies will reverse the ratio of unskilled to skilled technicians requiring these state-of-the-art facilities to invest their resources in highly skilled supply chain technicians. These technicians are the foundational employees who support and maintain the technologies ensuring continuous facility operation. As such, their role is invaluable to the organizations and their sustainability.

**Who comprises The National Center for Supply Chain Technology Education?**

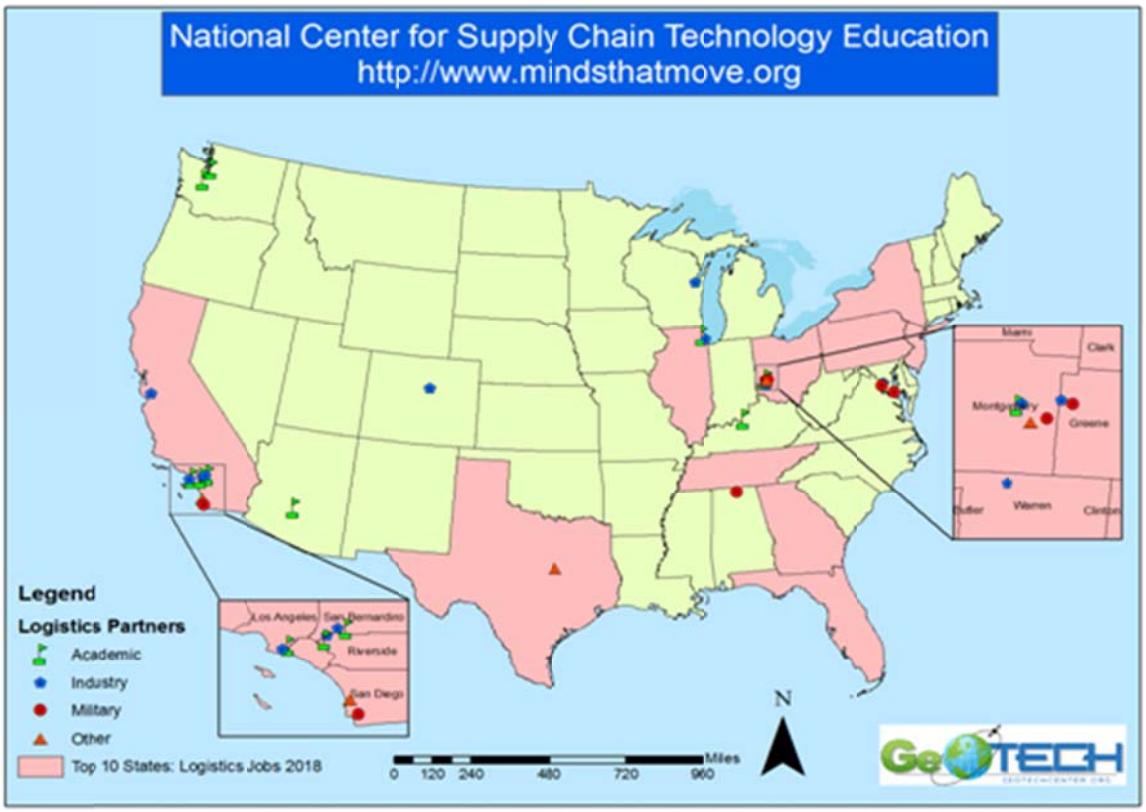
The National Center for Supply Chain Technology Education will be led by the Norco College of the Riverside Community College District (Norco, California) with co-principal investigators at community colleges across the country: Jefferson Community and Technical College (Louisville, Kentucky), Oakton Community College (Des Plaines, Illinois), Sinclair Community College (Dayton, Ohio), and Tacoma Community College (Tacoma, Washington).

Additional educational, industrial, commercial, and public sector partners from across the country will be involved. The logic for selecting the five partner community colleges is:

1. The institutions are highly respected nationally and have existing, robust technician education programs across the STEM disciplines to prepare technicians for employment in a variety of careers in private and public sector supply chain technology.
2. Norco College, part of Riverside Community College District, and Sinclair Community College are located in the two national supply chain centroids - which are geographical "places that have a high proportion of a country's population and a high proportion of its manufacturing, generally within 500 miles" (Page, 2009). According to Wright State University Professor and Chair of Information Systems and Supply Chain Management, Dr. Dwight Smith-Daniels, there are only two supply chain centroids in the United States: Riverside, California and Columbus/Dayton, Ohio (Page, 2009).
3. The institutions are strategically located in major concentrations of supply chain technology employers. The Riverside Community College District is located in the largest supply chain hub in the United States including the California Inland Empire of Riverside and San Bernardino counties, which are adjacent to the international Ports of Los Angeles and Long Beach—the largest in the country (Press Enterprise, 2008). According to labor market data, Riverside and San Bernardino counties alone rank sixth in the United States in terms of supply chain technology employment (EMSI, 2008a).

Principals of the National Center strategically selected partner community colleges which are located along the major national supply chain routes and have strong supply chain programs. The National Center for Supply Chain Technology Education will also involve partners across

the country strategically located in states with major supply chain technology activity (EMSI, 2009).




As part of the National Science Foundation's Advanced Technological Education (ATE) program, The National Center will also partner and network with other national and regional centers focusing on technology education. A National Visiting Committee and Industry Advisory Council will also advise, review, and guide the National Center (Siefert, 2003) to ensure serving employers and students across America.

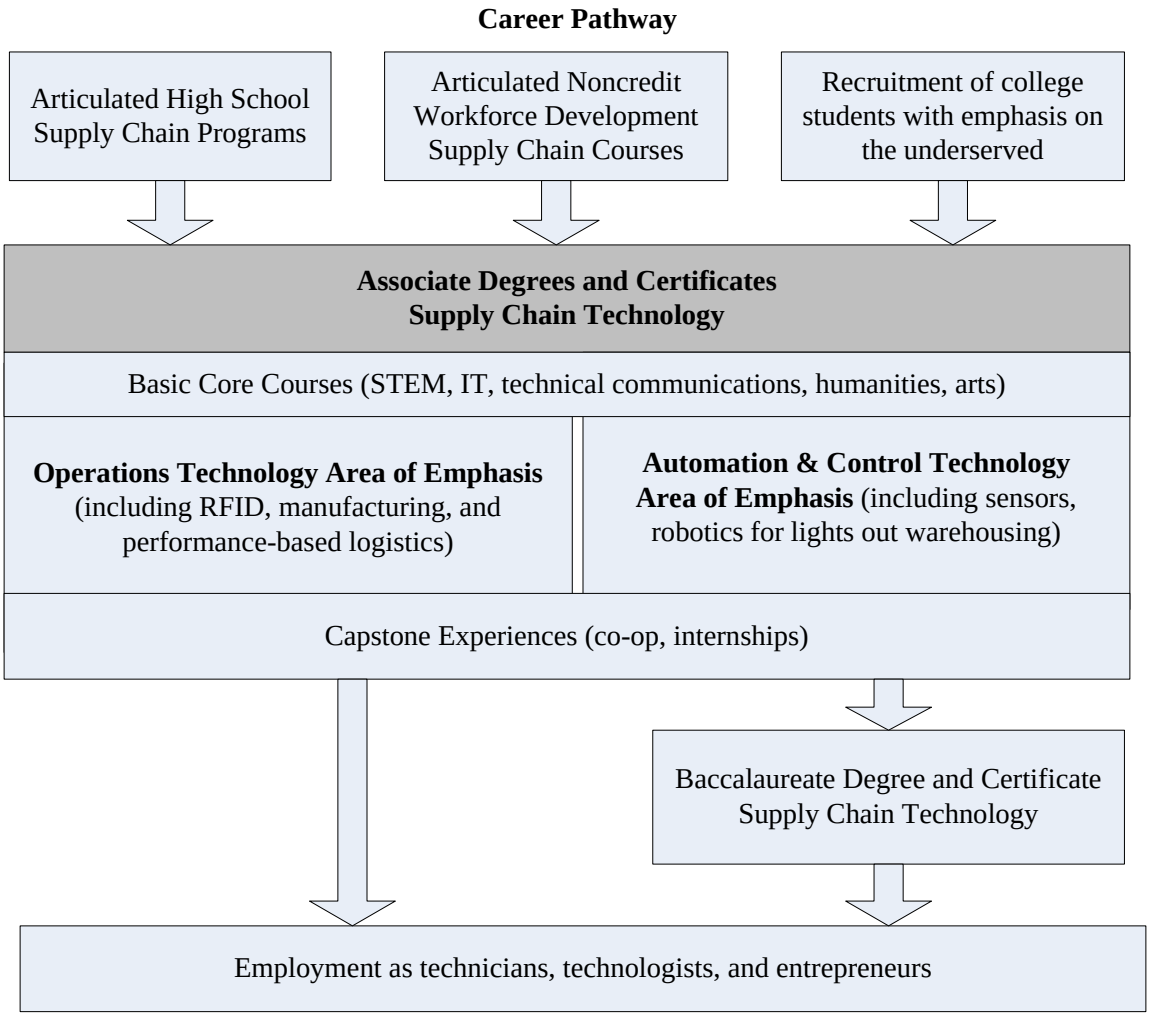
**The National Center's Goals and Activities**

This National Science Foundation (NSF) ATE Center will address the education of technicians that install, repair, support, maintain and improve supply chain technologies. The specific goal of the National Center for Supply Chain Technology Education will be to increase

the supply of highly qualified supply chain technicians by 20,000, over four years, to meet the growing national need across the private and public supply chains. The National Center will engage strategic partners across the entire private and public supply chain continuum: manufacturing, port operations, transportation (air, rail, and truck), distribution, warehousing, information technology, security, and public sector supply chain. To achieve the goal, the project leadership developed the following three main objectives:

- **Objective 1**: Implement a model 2+2+2 supply chain technology career pathway through high school/community college/university partnerships across the United States to meet the industry's needs for educated technicians. Programs of study will be based on the Supply-Chain Operations Reference (SCOR®) model (Supply-Chain Council, 2008) and all curriculum, instructional materials, professional development, and programming will be based on (1) the *Transportation, Distribution, and Logistics Competency Model* (U.S. Department of Labor, 2008), and (2) the *Human Capital Strategy* and *Core Logistics Competencies and Proficiencies* (U.S. Department of Defense, 2008).
- **Objective 2**: Increase the number of high school, community college, and university faculty participating in supply chain technology professional development. Activities will include workshops, webinars, faculty training, development of ready-to-use curriculum modules in supply chain technology areas, with a focus on increasing services to under-served populations and women in STEM fields (Allison & Cossette, 2007).
- **Objective 3**: Disseminate best practices in supply chain technology education via the project website: www.mindsthatmove.org. The National Center will also create and disseminate best practice documents, articles, newsletters, and case studies.

Over the next 4 years, the NSF National Center for Supply Chain Technology Education will create 2+2+2 career pathways beginning with courses in the junior year of high school and with articulated noncredit workforce development courses, seamless integration with associate degree and certificate programs, and transfer to baccalaureate degree programs. The pathway has multiple exit points to occupations with varying skill requirements. Two specific areas of emphasis at the community college level will be Operations Technology and Automation & Control Technology—both of which are STEM areas of study involving technical competencies. Given that Riverside, California and Dayton, Ohio are national supply chain centroids, a heavy focus will be placed on the technologies used in 21st Century warehouses.



## References


Allison, Charlene J. and Cossette, Imelda. (2007). *Theory and Practice in Recruiting Women for STEM Careers.* Women in Engineering Programs and Advocates Network (WEPAN). http://www.stemrecruiting.org/docs/pub/WEPAN07.pdf.

Brown, C., and Campbell, B. 1999. *The Impact of Technological Change on Work and Wages.* Penn State University. Downloaded from citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.84.9761&rep.

Castelli, Elise. (2009). How DoD Will Add 2,000 Acquisition Officers." *DefenseNews.* April 13, 2009.

Cole, Michael D. 2008. Knowledge Conference Highlights Increasingly Sophisticated Levels of Warehouse Technology. *Apparel Magazine*. August 2008.

CSCMP. (2009). Council of Supply Chain Management Professionals. *Fast Facts on the Global Supply Chain*. October 2009.

Dahmann, Judith S. and Kelley, Mike. (2009). Systems Engineering During the Material Solution Analysis and Technology Deployment Phases. Office of the Director, Defense Research and Engineering Systems Engineering, U.S. Department of Defense. September 2009.

EMSI Economic Modeling Specialists, Inc. (2009). National Complete Employment in SC/TDL 2009-2019. October 2009.

EMSI Economic Modeling Specialists, Inc. (2008a). California Complete Employment 2008-2018. Fall 2008.

EMSI Economic Modeling Specialists, Inc. (2008b). Covered Employment 2008-2018. Fall 2008.

EMSI Economic Modeling Specialists, Inc. (2008c). Greater Dayton, Ohio Complete Employment 2008-2018. Fall 2008.

Hoffman, W. 2006. Technology, Off the Shelf. *Traffic World*. July 17, 2006.

Intermec Technologies Corporation. 2077. *Top 10 Supply Chain Technology Trends White Paper*. http://www.intermec.com.

Kerzner, H. 1998. *Project Management: A Systems Approach.* New York: Van Nostrand Reinhold.

Khan, Mohammad Zubair, Omar Al-Mushayt, Jahangir Alam, and Jorair Amhad. 2010. Intelligent Supply Chain Management. *Journal of Software Engineering & Applications*. April 2010.

Ohio Department of Education. 2011. *Supply Chain Management: Marketing Career Field Technical Content Standards Document*. Columbus, Ohio. Ohio Department of Education. March, 2011.

Page, Doug. 2009. Dayton Region a Critical Hub for Supply Chain Management. *Dayton Daily News*. December 21, 2009.

Patterson, Kirk A., Curtin M. Grimm, and Thomas M. Corsi. Diffusion of Supply Chain Technologies. 2004. *Transportation Journal*. Summer 2004.

*The Press Enterprise*. (2008). Cargo's Crossroads: A Special Report. September 7, 2008. http://www.pe.com/reports/2008/cargo/pdf/20080907_goods.pdf.

Rost, David. April 22, 2011. Personal communications at facility tour of Cardinal Health in Ontario, CA.

Siefert, David. (2003). *Managing for Success: The Insiders Guide to NSF Project Management.* Dayton, Ohio: Sinclair Community College. 2003.

Shacklett, Mary. 2011. The 21st Century Warehouse. *World Trade*. March 2011.

Shacklett, Mary. 2010. You Made the Investment—Now What. *World Trade*. December 2010.

Siefert, David. 2003. *Managing for Success: The Insiders Guide to NSF Project Management*. Dayton, Ohio: Sinclair Community College.

Singh, Nitin, Kee-hung Lai, and T.C.E. Cheng. 2007. Intra-organizational Perspectives on IT-Enables Supply Chains. *Communications of the ACM*. January 2007.

Slone, Rueben, Paull Dittman, and John Mentzer. 2011. *New Supply Chain Agenda: The Five Steps that Drive Real Value*. Cambridge, MA: Harvard Business Press.

The Supply Chain Council. 2011**.** *Supply Chain Talent*. http://supply-chain.org/node/13796

The Supply Chain Council. 2008. *Supply-Chain Operations Reference-model*, version 9.0. http://www.supply-chain.org/cs/root/scor_tools_resources/scor_model/scor_model.

U.S. Department of Defense. (2008). *DoD Logistics Human Capital Strategy*. May 12, 2008.

U.S. Department of Labor. (2008). *Transportation, Distribution, and Logistics Competency Model*. June 24, 2008. http://www.careeronestop.org/competencymodel/pyramid.aspx?TSP=Y.

Van Sickle, Heather, "*The Value of Entrepreneurship Education at Community Colleges*," presented at the Creative Arts Entrepreneurship Forum, Mission College, CA, June 1, 2008, Downloaded at: http://www.nacce.com/resource/resmgr/nacce_creative_arts.pdf.