



## CA2VES, an NSF Regional Center, Enhancing the Engineering and Technician Education Pipeline

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Dr. Kris Frady is the Director of Operations for the Clemson University Center for Workforce Development. Additionally, she has earned experience in the corporate sector working with Blackbaud Inc., designing and delivering professional training seminars in online, blended, and live environments. She also has experience in the educational sector in both live and online environments as an adjunct instructor in computer technology for Greenville Technical College and as a Career and Technology Education teacher.

Kris earned a B.S. in Management from Clemson University, a Masters of Arts in Teaching in Business Education from the University of South Carolina, and an Ed.D. in Curriculum and Instruction with an emphasis in Educational Technology and online learning from the University of Florida.

Her research interests include implementation of digital learning solutions in technical and vocational education, development of career pathways utilizing stackable certificates, educator professional development in communities of practice, and analysis of economic development and industry factors impacting education and workforce development.

She is a licensed South Carolina Educator and serves on various boards to assist with implementation of workforce development is a statewide model including: the Anderson, Oconee, Pickens Showcase board, the technical college led Partnership for Academic and Career Education, Oconee County Work Ready Community Board of Advisors, and Pickens Career and Technology Center Advisory Board.

In over 10 years in development of educational and training materials Kris has designed and delivered professional development and training courses and seminars for 501-c3 organizations across the United States. Her experience as a professional educator has supported her development of educational resources, knowledge of P-12 and technical college systems and needs, and passion for educating youth. In her role as Director of Operations for the Center for Workforce Development she has guided development and assessment of innovative online educational material and the integration of digital learning and visualization tools. She has been part of a team involved in disseminating those results and models throughout numerous national conferences and peer reviewed conference papers. Finally, as part of an overall team she has worked to develop a system wide support network consisting of all 16 South Carolina technical colleges, state funded organizations, National Science Foundation Advanced Technological Education Centers across the United States, P-12 schools and districts across South Carolina, and many manufacturing industry partners to create pathways and resources for supporting advanced manufacturing advocacy and opportunities impacting employability and economic development across the Southeast.

### Dr. Kapil Chalil Madathil, Clemson University

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Hope E. Rivers is the Vice President for Academic and Student Affairs. She holds a Doctor of Philosophy in Educational Administration degree from the University of South Carolina (USC). Dr. Rivers is responsible for promoting communication and collaboration between the state Technical College System Office and the Vice Presidents of Academic and Student Affairs, Deans, and Directors at the 16 technical and community colleges in all areas related to curriculum and instruction, student services, and research. She also serves as the primary technical college system liaison to the SC Commission on Higher Education, certification boards, and a diverse group of agencies designed to address the educational and workforce needs in the state. Additionally, Dr. Rivers is the principal administrator and manager of several federal and state grants, which are distributed to the technical and community colleges across the state. Her 20-years of higher education experience provide a wealth of knowledge to draw from for a host of state-wide initiatives.

# CA<sup>2</sup>VES, an NSF Regional Center, Enhancing the Talent Pipeline to Support the Advanced Manufacturing Industry

## Introduction

The *Ready to Work: Job-Driven Training and American Opportunity* report identified three major problems in our employment and education system: (1) Employers can't find enough skilled workers to hire for in-demand jobs they must fill to grow their businesses; (2) Education and training programs need better information on what skills those in-demand jobs require; and (3) Hard-working Americans, whether studying, looking for work, or wanting better career paths, often aren't sure what education to pursue and whether jobs will be waiting when they finish.<sup>1</sup> The Center for Aviation and Automotive Technology Education using Virtual E-Schools (CA<sup>2</sup>VES) is an innovative regional center aiming to address these three major problems, and many additional challenges that have plagued workforce development projects.

The Center for Aviation and Automotive Technology Education using Virtual E-Schools (CA<sup>2</sup>VES), located at Clemson University in South Carolina, serves as a state, regional, and national resource for 2-year college e-learning research, professional development, and advanced curriculum based on the latest neuroscience principles, to help educate and prepare a sustainable, multi-skilled technological workforce for manufacturing technician and engineering technology careers. With its current regional center grant from the National Science Foundation Advanced Technological Education (NSF ATE) program, CA<sup>2</sup>VES continues to identify and meet the needs of 2-year college technological education faculty and students alike, and in particular, helps to reach and serve underrepresented students, with innovative e-learning research, recruitment and curriculum applications.

CA<sup>2</sup>VES is a strong, vibrant, proactive partnership between Clemson University and the Clemson University Center for Workforce Development; the SC ATE National Center of Excellence; Florence-Darlington Technical College; Greenville Technical College; and Trident Technical College. Additionally, collaborative partners include NSF ATE Centers; all sixteen South Carolina 2-year colleges and their high school partners; and the South Carolina automotive and aviation industry. Although headquartered at Clemson, the primary focus of CA<sup>2</sup>VES is supporting technological education in 2-year colleges through digital learning tools. The 2-year colleges who partner with CA<sup>2</sup>VES work to create products that improve the access to, and quality and capacity of, associate degree technology programs and certificates to educate an advanced manufacturing, aviation, and automotive manufacturing workforce.

CA<sup>2</sup>VES distinctive approach has yielded many exciting deliverables and results that may be immediately utilized by 2-year college faculty and administrators in advanced manufacturing and engineering technology programs.

- (1) Creation of an innovative, high-impact personalized digital learning curriculum model for educating 2-year college students and industry employees in advanced manufacturing (over 30 virtual reality tools and simulations and over 80 advanced e-learning modules, developed by CA<sup>2</sup>VES, are being integrated into technological education programs nationwide).

- (2) Development of recruiting and pathway development resources to attract and retain underrepresented groups to advanced manufacturing career pathways and 2-year college technological education programs (development and distribution of e-learning lessons, videos and tools in K-12 classrooms, and incorporation of industry partnerships in multiple large scale recruitment campaigns).
- (3) Broad dissemination and development of the virtual school as a standard pedagogical tool (development of methodology to evaluate pedagogical effectiveness and analysis of utilization of digital learning tools to determine impact).
- (4) Creation of a model of a national collaborative venture among universities, NSF ATE Centers and Projects, 2-year colleges, high schools, and key industries (utilization of ATE Centers and Projects nationwide to support digital learning tool distribution and dissemination; partnership and program implementation with over 80 educational institutions – 2-year colleges, K-12, 4-year universities and educational organizations, over 70 industry partners and over 15 community based and governmental agencies).

CA<sup>2</sup>VES, an educational program unlike any other in the US and with the full backing of key industry employers, federal government agencies, state workforce departments, and secondary and post-secondary educational institutions, is providing sustainable resources to support the vital role played by 2-year programs in the engineering and technological education pipeline.

## **A Workforce Development Solution Designed to Support Economic Development Needs**

### A Sector Based Strategy

Despite its decline in the late 1990s and early 2000s, the advanced manufacturing sector plays a critical role in the US economy contributing \$2.09 billion; a financial impact which has risen steadily since 2009 and presently accounts for 12 percent of gross domestic product.<sup>2</sup> Jobs in advanced manufacturing have also experienced steady growth during this period of time where current estimates suggest that over 12 million Americans (approximately nine percent of the workforce) are directly employed in manufacturing.<sup>3</sup> Interestingly, the manufacturing sector employs, on average, a higher number of workers without a college degree than the overall economy; almost 11 percent more than similar workers in the rest of the economy in 2012-2013.<sup>4</sup> However, as advanced manufacturing jobs become increasingly technologically advanced the need for a more highly qualified and educated workforce has begun to emerge where the percent of manufacturing employment by educational attainment has seen a steady increase in the need for some college or a college degree.<sup>5</sup>

In the recently released White House report, *Accelerating US Advanced Manufacturing*, it is stated that the US manufacturing sector draws its strength from a “multitude of tightly linked capabilities contributed by the private sector, academia, and labor” and as manufacturing grows and strengthens in the United States, a broad public-private coalition has emerged in support of American manufacturing.<sup>6</sup> Given these factors plus present and projected growth of the advanced manufacturing sector, CA<sup>2</sup>VES continues to develop solutions and strategies which have a primary focus on workforce development solutions targeted at supporting employment needs of advanced manufacturing industries specifically automotive and aviation manufacturers.

Further, sector-based initiatives have been found to serve as successful avenues for establishing greater understanding and better relationships between workforce practitioners and employers.<sup>7</sup>

### Establishing Regional Partnerships to form Workforce Development Infrastructure

To be certain, many institutions and organizations in the US are implementing programs that have innovative and effective elements. But their success is often thwarted by being overly complex, fragmented or lacking in transparency.<sup>8, 9, 10</sup> They are also challenged by limited employer engagement, inconsistent delivery of training and education, a disconnect between secondary education and the labor market, challenges in the 2-year college system, inefficiency, and increased difficulty of the public and employers' understanding and accessing workforce development programs.<sup>11</sup> Further, funding of workforce development initiatives, in many cases, is heavily reliant on federal funding sources<sup>12</sup> which have declined in recent years, imposing structural limitations. In order to meet the overwhelming human capital demands of the US today and in the future, regional workforce development initiatives “must act strategically to establish partnerships and leverage resources that will enable them to meet the increasingly complex employment and skill needs of jobseekers, employers, and their regional economies in the future.”<sup>13</sup>

Indeed, regional and community-based workforce development initiatives are being recognized as increasingly appropriate in addressing workforce development challenges.<sup>14</sup> Regional are better than local efforts at identifying and filling skills gaps and aligning workforce systems.<sup>15</sup> The regional initiatives experiencing the greatest successes have created institutional collaborations, which focus on building greater public-private collaboration and cooperation.<sup>16</sup> Many successful examples of regional collaborative programs have been implemented however, best practices emerging from these initiatives have not been widely disseminated, are not often backed by solid evidence and typically do not extend to other regions which may benefit.<sup>17</sup> Another challenge in the field of workforce development stems from a lack of common, agreed upon definitions, outcomes, measures and benchmarks.

The *Ready to Work: Job-Driven Training and American Opportunity* report “emphasized the importance of looking beyond our federal programs and agencies for answers and best practices.” Workforce development programs must begin working together across county and state lines, create common visions and understanding, reduce redundancy of effort leverage resources from both private and public sources. A new national learning exchange model must emerge to facilitate leaders in the workforce development field in innovation of new approaches, implementation of an evidence-based approach to establish and disseminate effective practices and scaling or replicating promising models to meet more widespread adoption.<sup>18</sup> CA<sup>2</sup>VES aims to embody such a model and through its distinctive approach has had the ability to not only impact learning and curriculum but also has established regional partnerships with outcomes reflective this learning exchange model.

## The CA<sup>2</sup>VES Approach

### (1) Innovative, high-impact personalized digital learning curriculum

According to a 2012 study produced by Deloitte LLP approximately 600,000 skilled manufacturing jobs are going unfilled due to a skills gap between workforce requirements and labor market ability.<sup>19</sup> An aging workforce further compounds this issue where projections show that in 2030 more than 20 percent of the workforce will be over 65 compared to 13 percent in 2010 and 9.8 percent in 1970.<sup>20</sup> This means that manufacturing employers are not only combating current labor shortages but they are also deeply concerned about an impending labor shortage crisis caused by a “graying” workforce. Addressing this skills gap is a national priority where industry leaders have reported that if unresolved could compromise their ability to stay competitive.<sup>21</sup> At this crucial juncture, it is incumbent upon educational institutions and workforce development initiatives to find innovative approaches to skill-up the current labor force while also creating a pipeline of highly-skilled next generation manufacturing technicians and engineers.

An obstacle that the manufacturing and A<sup>2</sup> programs at 2-year colleges face is attracting young, more technology-oriented students. Additionally, these schools are limited by funding, availability of high technology resources, and are typically restricted by an infrastructure which was initially designed to support the use of traditional face-to-face educational methodology. Further, despite the development of numerous technology-based, education and workforce preparedness tools; opportunities for technical education students to utilize these tools and engage in contextual learning are still emerging. CA<sup>2</sup>VES, a state-of-the-art virtual e-school center, seeks to alleviate these pressures by leveraging statewide and other existing NSF ATE center expertise to offer a distinctive solution to these challenges through implementation of a technologically infused infrastructure delivering e-learning in a virtual classroom environment.



Figure 1. Instructional materials

Digital learning solutions developed by CA<sup>2</sup>VES' include high-impact, hands-on virtual reality and 3D visualizations and also focus on engaging, computer enhanced teaching techniques, and hands-on laboratory experiences; the combination of which offers student-centered, contextual, authentic learning experiences (see Figure 1). It is difficult to make real-world learning experiences widely available in the classroom to students because of parameterization issues (too many variables to manipulate) and the availability and cost of equipment and machinery. The flexibility inherent in e-learning and virtual classrooms offers CA<sup>2</sup>VES new avenues to not only attract more technology-oriented students but also capacity to reach new students in locations (including areas lacking geographical access to necessary education). Further, the educational design of the digital learning tools helps the learner to develop both basic and critical thinking skills, reduce learning time and immerse the learner in an environment that would be otherwise unavailable. Previous studies<sup>22,23</sup> have proven that highly interactive learner-centric education experiences have results in significant gains in student learning, retention, reinforcement and knowledge transfer. Finally, faster transfer of knowledge and greater retention are facilitated by effective and timely feedback and the opportunity to practice a new skill.

CA<sup>2</sup>VES is also integrating technology to address challenges such as equipment limitations, class size, and student scheduling constraints. Much of the learning and skills development in traditional technological education programs takes place through hands-on laboratory experiences. We have developed virtual reality tools to make these lab experiences more accessible. While these tools are not intended to completely replace a lab experience, they provide students with the opportunity to spend more time practicing with equipment and experiencing simulated industrial environments so they are more successful during labs.

CA<sup>2</sup>VES has strived to implement the learnings from existing research in each of its over 30 virtual reality simulations which include a variety of precision measurement tools, basic electricity measurement tools, computer numerical control (CNC) machines, grinding machines, a tool box and a fully stereoscopic turbine engine, gas combustion engine and brake system. CA<sup>2</sup>VES has also developed fully immersive environments where a user can enter a factory (modeled after the Greer, South Carolina BMW facility) and perform a safety audit tagging any detected violations.

Additionally, CA<sup>2</sup>VES has developed over 50 advanced e-learning modules which provide wraparound curricula to more seamlessly incorporate the virtual reality into the student learning process. These modules include outlines, e-text, assessment guides, presentations files, and other pedagogically designed educational support resources. These models have been designed in courses and include fresh innovative ways to teach Metrology, Safety, Manufacturing Production, Quality, Maintenance, Basic Electricity, Workforce Fundamentals (soft skills), and several other areas.

The virtual reality simulations and e-learning modules are sustained by academic, technical, and engineering knowledge from across the states 2-year colleges, Clemson University, CU-ICAR (International Center for Automotive Research) and leading industries (BMW, Michelin, Honda, Lockheed Martin, Boeing, and GE Aviation). CA<sup>2</sup>VES seeks to address the shortage of automotive and aviation technicians through the development and implementation of an advanced, high-tech pedagogical approach designed to enhance and increase the capacity of 2-year colleges and to increase the number of highly skilled graduates in a more cost-effective way.

## (2) Technological Education Recruitment and Pathway Development

CA<sup>2</sup>VES is committed to creating future technicians, engineers and scientists who can be productive in a global economy. The combination of pathway development and recruitment focused programs have experienced success in providing a number of experiential learning opportunities that require students to transfer academic knowledge and experience from the classroom to real-world work environments. Building innovative career pathways to support technological education careers helps to provide greater economic growth and development in manufacturing and A<sup>2</sup> industries throughout the region. CA<sup>2</sup>VES employs a two pronged approach to impact recruitment and career development: (1) support of educational pathway development and (2) utilization of K-12 STEM initiatives to engage the next generation of students and workers in advanced manufacturing learning and skill development. Through pathway development programs CA<sup>2</sup>VES is able to work with local 2-year colleges to develop a pipeline of next generation technicians with the capacity to positively impact the region's growing economy.

By 2018, it is projected that over 40 percent of advanced manufacturing jobs will require post-secondary education.<sup>24</sup> Post-secondary education may include industry recognized certification, associate's degrees, bachelor's degrees or beyond where any post-secondary attainment may have the ability to significantly impact an individual's earning ability.<sup>25</sup> Creation of educational pathways enabling students, veterans, adults and incumbent workers to have both

access to and a seamless transition between various types of post-secondary educational attainment is vital to increasing overall educational attainment throughout the region. Pathway development may include stackable certificates, creative ways to address credentials, innovative articulation programs, increasing industry's role in curriculum development and communication and strategic planning across educational and workforce entities system wide. Based on results from similar initiatives in other countries, creation of high-quality pathways could be the single most important strategy for increasing post-secondary degree or credential attainment.<sup>26</sup> To support development of an advanced manufacturing pathway throughout the region CA<sup>2</sup>VES is creating e-modules which will aid learners in attainment of an industry recognized credential, creating Memorandums of Understanding with 2-year colleges outlining first steps in creation of seamless transfer opportunities, and providing opportunities for key educational stakeholders to discuss, collaborate, and delve deeper into creative articulation solutions.

CA<sup>2</sup>VES has also developed expertise utilizing K-12 STEM education as an area to expose students to careers and educational pathways in advanced manufacturing. Recently CA<sup>2</sup>VES joined public funds with over \$4 million in private funds from Duke Energy Foundation to create and support new technology labs and equipment, develop new curriculum, support collaborations among multiple 2-year colleges, develop summer camps for recruitment and provide scholarships supporting STEM majors. Implementation of this entire initiative impacted over 60 percent of South Carolina's K-12 school districts, over 70 percent of South Carolina 2-year colleges, five 4-year institutions and numerous STEM and community and non-profit organizations. Working to create manufacturing career exposure opportunities through STEM education is important because student, parent, and teacher perceptions of manufacturing facilities bear little resemblance to the modern, high-technology facilities across the United States. In order to meet the growing workforce demand (of current facilities and facilities that the nation may hope to attract) it is imperative that students and parents be educated of these career opportunities provided with educational resources, training, and immersion experiences to encourage them to consider these growing employment opportunities. To address this, CA<sup>2</sup>VES has engineered a robust digital learning curriculum gathering input from leading advanced manufacturing employers aimed at not only generating greater exposure to these lucrative and needed careers but also to beginning to address the skills gap identified by these employers. This digital learning curriculum has been implemented across the K-12 spectrum as the following programs:

- Elementary school (focusing on *Exposure*): Introduction to jet turbine engines and precision measurement with virtual reality Vernier Calipers through the eyes of CA<sup>2</sup>VES mascot, Mr. Beetle
- Middle school (focusing on *Exploration*): Leadership in implementation of the Business and Industry Showcase, impacting around 5,500 8th grade students annually, in curriculum development, planning, and implementation of a manufacturing career exploration immersion experience
- High school (focusing on *Immersion*): Development of digital learning tools, lesson plans, creation of Workforce TV video, and piloting of CA<sup>2</sup>VES developed industry recognized certification materials with 10th graders in a career center

Additionally, CA<sup>2</sup>VES has supported STEM guidance counselor and career counselor events and activities while also hosting national conference tracks, regional workshops webinars and onsite training for K-12 teachers and guidance and career counselors. Finally, CA<sup>2</sup>VES has utilized



industry partnerships to develop and implement program-specific recruitment activities: two Professional Development Educator Forums (over 150 educators and over 20 industry representatives participated); various workshops (over 60% of SC school districts participated); Workforce TV videos (GE, BMW, Michelin, Boeing and Fluor partnered to develop); a national conference track focused on technological education (over 300 attended the conference, 50 in the CA<sup>2</sup>VES/CUCWD track); and multiple career fairs and activities partnering with over 40 South Carolina businesses. Through STEM career pathways, recruitment events, student activities and engagement, and professional development opportunities; CA<sup>2</sup>VES is developing a pipeline of next generation of technicians, scientists and engineers with the capacity to positively impact the growing economy.

### (3) Broad Dissemination of Advanced Technology Digital Learning Tools

In order to maximize the impact of CA<sup>2</sup>VES research and development, CA<sup>2</sup>VES has also implemented a wide dissemination plan to leverage its recognized and proven work to date. Additionally CA<sup>2</sup>VES has viewed dissemination as an opportunity to promote the profile of the Center and strengthen its research capacity and reach. Dissemination efforts of the Center are implemented in four strategic areas:

- (1) Partnerships: CA<sup>2</sup>VES leverages partnerships and networking with a variety of partners and stakeholders system wide including those within the NSF ATE program, educational institutions ranging from K-12 to 2-year colleges to 4-year universities, dedicated business partners, professional associations and academic organizations, and non-profit and community organizations. This network of partners is not only key to dissemination of findings and products produced by CA<sup>2</sup>VES; but are also CA<sup>2</sup>VES key to success, sustainability and relevance within the region.
- (2) Events: CA<sup>2</sup>VES shares its findings and resources through multiple events sponsored throughout the year. The Center holds workshops, seminars, webinars and has even sponsored a Workforce Development track in a national conference. These events are an opportunity to not only disseminate resources but also to gather feedback, make new partnerships and strengthen existing partnerships. These events focus on best practices in implementation of digital learning tool and virtual reality resources, educator professional development, connecting local industry with schools and information about the strength and vibrancy of advanced manufacturing careers throughout the region.
- (3) Publications and Presentations: CA<sup>2</sup>VES is active in promoting and developing a community of scholars in virtual reality and digital learning to support technological education in advanced manufacturing. The researchers at the Center have engaged in a variety of academic dissemination efforts including presenting at numerous state and national level conferences, publications in peer-reviewed journals, and periodic press releases and op-ed articles in local and national media sources. Additionally, CA<sup>2</sup>VES produces and distributes a quarterly newsletter and intermittent white papers and reports on findings from events and special research projects.

- (4) Online Dissemination: All curricula digital learning materials created by CA<sup>2</sup>VES are distributed to stakeholders via an online portal [www.educateworkforce.com](http://www.educateworkforce.com) created by CA<sup>2</sup>VES and Clemson University Center for Workforce Development staff. Additionally, ATE Central (<https://atecentral.net/>) is also a repository where some materials from the Center are archived and may be accessed.

CA<sup>2</sup>VES has a vision for broad implementation and dissemination of manufacturing transportation e-learning tools nationwide utilizing NSF ATE Center partners and its unique learning platform [www.educateworkforce.com](http://www.educateworkforce.com) (see Figure 2). The National Academy of Engineering (NAE) has also recognized dissemination of e-learning tools to 2-year colleges to support technical of STEM education to be of the highest priority.<sup>27</sup> Educateworkforce.com is a learning solution portal offered with partnering technical colleges to help successfully blend powerful online and digital solutions into their existing courses. This portal is the first of its kind specifically built for and tailored to the unique needs of 2-year and technical education and will consist of both basic and advanced courses focusing on the needs of technician students and will provide a selection of courses.

This site is an ideal way to develop and refine novel online learning experiences. Students may have access to self-paced learning tools or faculty may choose to integrate modules, iBooks, brief video lectures, virtual reality simulations, and instant feedback assessments into their existing courses. Moreover, the site will be able to offer a robust catalog of state-of-the-art materials and digital learning resources through the integration of courses developed by integral partners including 2-year colleges from the Department of Labor Trade Adjustment Assistance Community College and Career Training grant program, NSF ATE centers and programs nationwide, and many others. NSF ATE Center partners nationwide are also assisting in introducing and distributing digital learning tools and information about Educateworkforce.com to 2-year colleges and technological education programs throughout the Southeast.

The Educateworkforce.com platform was designed by multiple instructional design, usability, network and computing experts to include many research tested learning features. The platform represents a new approach to learning seamlessly integrating Universal Design for Learning (UDL) principles for curriculum development to give all individuals equal opportunity to learn. The platform embraces leading neuroscience research and designed to meet the needs of three primary brain networks: (1) recognition networks, (2) strategic networks, and (3) affective networks.

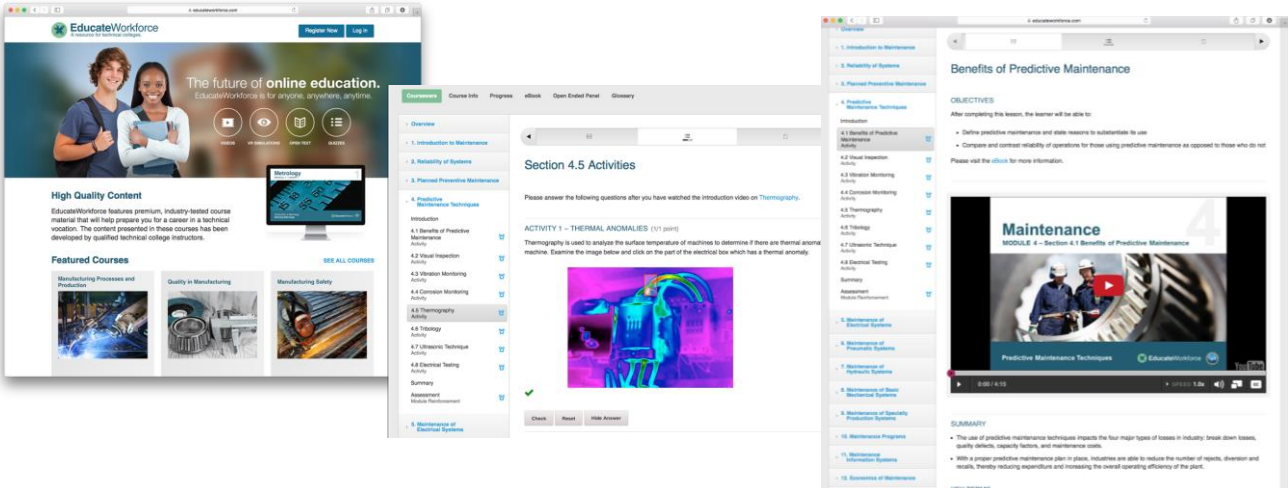


Figure 2. EducateWorkforce Platform

(4) A model of a national collaborative venture

Through its efforts, CA<sup>2</sup>VES has created a model of a national collaborative venture among universities, NSF ATE Centers and Projects, 2-year colleges, high schools, and key industries (utilization of ATE Centers and Projects nationwide support digital learning tool distribution and dissemination; partnership and program implementation with over 80 educational institutions – 2-year colleges, K-12, 4-year universities and educational organizations, over 70 industry partners and over 15 community based and governmental agencies). Through this immense network of partners, CA<sup>2</sup>VES has established itself as a leader in workforce development in the region and in March 2014 was asked to lead and host a roundtable discussion for US Secretary of Commerce Penny Pritzker. The roundtable discussion included topics on how to develop a well-qualified workforce, how workforce development systems and employers ensure education leads to an in-demand job, and continuation of educational alignment with the region’s economic growth. In a CNBC interview following the visit, Secretary Pritzker said, “I was in South Carolina this week...at a plant that’s working with Clemson University, the local technical colleges and the local businesses to help workers get the skills they need. And what you see is that kind of effort is extremely useful and valued not just by the worker but also by the businesses.” This roundtable and its results embody the mission and charge of CA<sup>2</sup>VES and have further elevated the Center’s leadership role in the field of workforce development.

Public-Private Partnerships Creating Next Generation Technicians

In today’s shrinking federal and state funding environment it is becoming increasingly necessary for a sustainable NSF ATE Center or project to shift the paradigm from one engaged primarily with public funding to one which engages not only private funding but also new and diverse funding sources. CA<sup>2</sup>VES has experienced much success through its focus on identifying synergies between NSF ATE priorities and emerging non-public funding opportunities. The emerging opportunities include exploring private funding working with corporate foundations and redesigning the business model of an ATE Center or project to focus on new and diverse revenue opportunities.

With over \$11 million in public-private funding since 2011, CA<sup>2</sup>VES supports education, training, and workforce initiatives and seeks to improve manufacturing and industry competitiveness. CA<sup>2</sup>VES has an established local and national capacity through management of CA<sup>2</sup>VES, acting as the lead educational consultant on three Department of Labor Trade Adjustment Assistance Community College and Career Training Grant Program – DOL TAACCCT), managing statewide workforce development foundation implementation for various private industries, and acting as the lead organization for an Economic Development Administration Make it in America consortium. Also, CA<sup>2</sup>VES has expertise in administering, implementing, and attracting private sector investments. This is evidenced by a successful history of public-private collaboration on similar projects. The Center for Workforce Development and CA<sup>2</sup>VES recently managed \$4.11 million dollar foundation agreement with the Duke Energy Foundation to implement economic development focused workforce development initiatives across the state of South Carolina. A key component of all of the funding opportunities that CA<sup>2</sup>VES has leveraged is the complementary missions, programs and foci across deliverables. This complementary perspective has enabled each individual program to become part of a larger strategic initiative thereby empowering each to have greater impact, support and sustainability. Through leveraging and linking public and private funds, CA<sup>2</sup>VES has been able to exponentially increase its impact in advanced manufacturing technological education throughout the region.

### Sustainability

The CA<sup>2</sup>VES funding model identifies key activities, stakeholders, a multi-layered framework for research and planning for long-term sustainability, and a detailed matrix on utilization of resources.<sup>28</sup> The matrix focuses on prioritizing activities based on their classification as positive or negative financial return and market growth, as compared to high or low benefit, social impact or market share. Within each of these categories, strategies such as maintaining, cutting, cautious expansion, or careful nurturing, can help direct the use of funds so as to maximize the allocation of financial resources.

To help sustain its work and fulfill its mission into the future, CA<sup>2</sup>VES maintains a comprehensive portfolio of expertise, resources, and services readily available to colleagues and partners in education, government, and industry. CA<sup>2</sup>VES builds on this base as it eventually prepares to transition into a National Resource Center for the ATE community. Through its strategic and sustainability planning efforts, CA<sup>2</sup>VES will concurrently: 1) improve the effectiveness of collaborative interactions with multiple stakeholder groups (e.g., NSF ATE Centers and projects, educational organizations and schools, industry, government agencies, regional board partnerships and their affiliated representation, and Clemson University partnerships); 2) develop funding for and extend the research base and long-term impact of CA<sup>2</sup>VES; and 3) develop new and diverse funding sources via consulting services to education and industry partners interested in implementing VR, E-Schools, or digital teaching and learning materials in online and hybrid environments.

## Summary

In order to create a strong U.S. manufacturing and industry sector and make the United States a magnet for new jobs and manufacturing, businesses and universities must explore unique ways to partner to leverage public-private resources for turning strategic regions into global centers of high-tech jobs. An educated, skilled and innovative workforce is vital to manufacturers' success and sustainability and education must be robust and accessible to encourage industry to locate and expand throughout strategic regions. Strong, collaborative ties between educational entities and manufacturers must be paired with a targeted focus on talent pipeline development, education and training in order for companies to capitalize on the research and resources emerging from initiatives such as CA<sup>2</sup>VES. In future initiatives, CA<sup>2</sup>VES will focus on utilizing and better implementing an established system-wide model of workforce development to create a pathway between education and industry enabling the latest training methodologies and technologies to support and extend their workforce quality and productivity targets.

For a large scale endeavor to be successful for implementing a workforce development methodology, selection of an established model from an organization having experience implementing this model is critical to ensure maximize impact. CA<sup>2</sup>VES has not only created and established such a system-wide model in a statewide application but has also established a sustainable infrastructure to support this model. Through regional education and professional development, the CA<sup>2</sup>VES model can be taught and replicated to support workforce development in other regions.

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