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Innovations in Quality Apprenticeships for high-skilled manufacturing jobs in the United States

Monika Aring

In close collaboration with Josée-Anne La Rue

Skills and
Employability
Department

Innovations in Quality Apprenticeships for high- skilled manufacturing jobs in the United States At BMW, Siemens, Volkswagen

Monika Aring

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Foreword

This is a report of three youth apprenticeship programmes in the United States conducted by the Skills and Employability Branch in the ILO's Employment Policy Department. The research aimed to produce evidence and analysis of quality apprenticeship programmes for youth in high-skilled manufacturing jobs.

After a period of fading interest in formal apprenticeship systems internationally, the aggravated global youth employment crisis of the last few years has brought apprenticeship back to the forefront of the policy agenda. It is recognized that countries with well-established apprenticeship systems tend to be better at managing school-to-work transitions for youth and as a result, their youth unemployment rate is close to that of adults, whereas it tends to be two to three times the adult unemployment rate elsewhere. However, attempts to "export" apprenticeship systems to countries have failed in many cases, perpetuating doubts about the prospects for building up successful apprenticeship systems where they are needed.

Renewed interest in apprenticeship systems was evident in the tripartite discussions on the youth employment crisis at the International Labour Conference in June 2012. Representatives of governments, employers' groups and trade unions highlighted repeatedly that apprenticeships are effective means of bridging school and work by making it possible for young people to acquire work experience along with technical and professional training. They encouraged member States to strengthen apprenticeship systems and requested the ILO to provide assistance, especially in adapting good practices for quality apprenticeship to a broad variety of national and industry circumstances.

Efforts to establish apprenticeship systems by German companies, with their rich apprenticeship experience at home, in their investments in the United States, provided a natural experiment to study the transfer and adaptation of apprenticeship to a new environment. This paper investigates quality apprenticeship in three German companies (BMW, Siemens and Volkswagen) that initiated apprenticeship programmes in the states of North Carolina, South Carolina and Tennessee in the southern part of the U.S. The report highlights the strong involvement of the three companies and their active cooperation with community colleges and municipalities in training apprentices in mechatronics, an interdisciplinary area of engineering that combines mechanical and electrical engineering with a high content of computer skills and software knowledge.

The ILO has a broad research interest in examining the effectiveness of initiatives to build up quality apprenticeship programmes: sharing the concerns of students to expand viable pathways from school to work, of employers to secure skilled workers and improve productivity, of community education institutions to improve the quality and relevance of their training, and of municipal governments to work with industry to generate high-quality local jobs. By assessing the employment outcomes of these programmes, this paper draws lessons for start-up apprenticeship partnerships elsewhere on what it takes to develop and maintain quality apprenticeship systems.

I would like to thank Ms. Monika Aring, the main author of the report, for preparing these analytical case studies, drawing on her extensive research and policy experience in the area of quality apprenticeships. The report was finalized in close collaboration with Ms. Josee-Anne La Rue, working in the Skills and Employability Branch. Mr. Michael Axmann, ILO Specialist in Skills Development Systems, initiated and managed this research project.

Christine Evans-Klock

Chief, Skills and Employability Branch

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Acronyms

ABD	Asian Development Bank
ACT	American College Testing Service
AG	Aktiengesellschaft (incorporated)
AMP	Automation Mechatronics Programme
ASTD	American Society for Training and Development
CEO	Chief Executive Officer
CMP	Car Mechatronics Programme
CNC	Computer Numerically Controlled
CPCC	Central Piedmont Community College
CSCC	Chattanooga State Community College
CSTC	Chattanooga State Technical College
EPA	Environmental Protection Agency
ESA	Equipment Services Associate
FT	Full time (work)
GE	General Electric
GPA	Grade Point Average
GTC	Greenville Technical College
IADB	Inter-American Development Bank
NAM	National Association of Manufacturers
NCCC	North Caroline Community Colleges
NDT	Non-destructive testing
OJT	On-the-Job Training
OSHA	Occupational Health and Safety Administration
PLC	Programmable Logic Controls
PPP	Public and Private Partnerships
SCC	Spartanburg Community College
SIDA	Swedish International Development Cooperation Agency
STEM	Science, Technology, Engineering, Mathematics
TCT	Tri-County Technical College
TTC	Tennessee Technology Center
UNC	University of North Carolina
UNESCO	United Nations Educational, Scientific and Cultural Organization
VOC	Volatile, Organic Compounds

Executive summary of three case studies: Strengths and weaknesses against the Key Elements of Quality Apprenticeships

G20 Labour and Employment Ministers agreed in their meeting in Guadalajara to “Promote, and when necessary, strengthen quality apprenticeship systems that ensure high level of instruction and adequate remuneration and avoid taking advantage of lower salaries.” Quality apprenticeships have been considered by the G20 Task Force on Employment as one of the key policy tools to promote effective school-to-work transitions.

It is recognized that countries with well-established apprenticeship systems tend to be better at managing school-to-work transitions for youth and as a result, their youth unemployment rate is close to that of adults, whereas it tends to be two to three times higher in other countries. However, attempts to “export” apprenticeship systems to countries have failed in many cases, perpetuating doubt in the international skills development community about the prospects for building up successful apprenticeship systems where they are needed.

Efforts to establish apprenticeship systems by German companies, with their rich apprenticeship experience at home, in their investments in the United States, provided a natural experiment to study the transfer and adaptation of apprenticeship to a new environment. The ILO commissioned a study of apprenticeship programmes initiated by three German companies (BMW, Siemens and Volkswagen) in their manufacturing plants in the southern US states of North Carolina, South Carolina and Tennessee. The report highlights the companies’ cooperation with community colleges and municipal and state governments in providing high-skill apprenticeships in mechatronics, an interdisciplinary area combining mechanical and electrical engineering with a high content of computer skills and software knowledge.

The ILO case studies examine the effectiveness of apprenticeships in closing the skills gaps, document key aspects of the public and private partnerships that created the apprenticeship programmes, assess the economic arguments for apprenticeship systems, summarize results for both young people and employers, and identify lessons for initiating apprenticeship systems elsewhere.

Given the differences in apprenticeships and taking into consideration the diversity of national contexts in the G20 countries, a set of characteristics were identified by the G20 Employment Task Force, in collaboration with OECD and ILO, as Key Elements that quality apprenticeship programmes may include in their design and implementation. ***The following table compares the strengths and weaknesses of the apprenticeship systems in the three case studies against these 16 Key Elements (KE) of Quality Apprenticeships.***

Key Element (KE) of Quality Apprenticeship	Findings from 3 case studies	
	Strengths	Weaknesses/Opportunities
KE 1. Key participants in the programme Young people; Employers; Trade unions; Training and education institutions and vocational schools; National, regional and local governments.	<ul style="list-style-type: none"> ➤ Inclusion of high school students ➤ Corporate leadership drives the programme ➤ Close partnership with local Community Colleges 	<ul style="list-style-type: none"> ➤ Quality apprenticeship work has not (yet) led to industrial competitiveness strategy ➤ Little involvement by Trade Unions
KE 2. Main objectives of apprenticeship programmes	<ul style="list-style-type: none"> ➤ Focus on high-level skills; Provides a seamless transition from school to work 	<ul style="list-style-type: none"> ➤ Good results at firm level could inform systemic programmes at sector or regional level
KE 3. Main beneficiaries	<ul style="list-style-type: none"> ➤ Three way benefits for companies, young people and community colleges 	<ul style="list-style-type: none"> ➤ Opportunity to leverage of apprenticeship investments across employers and school districts
KE 4. Rights of participants	<ul style="list-style-type: none"> ➤ Strong focus on occupational safety and health; Active encouragement to young women to participate 	<ul style="list-style-type: none"> ➤ No legal framework yet for the protection of the rights of young apprentices
KE 5. Income and support for apprentices	<ul style="list-style-type: none"> ➤ Apprenticeship wages comply with state and federal minimum wage requirements 	<i>None identified</i>
KE 6. Apprenticeship funding	<ul style="list-style-type: none"> ➤ Considerable investments by the companies and commitments on the part of each state involved 	<ul style="list-style-type: none"> ➤ Lack of sustainable funding mechanisms on the parts of the states involved
KE 7. Eligible occupations for apprenticeship programmes	<ul style="list-style-type: none"> ➤ Strong demand for mechatronics technicians 	<i>None identified</i>
KE 8. Appropriate education levels to incorporate youth into apprenticeship programmes	<ul style="list-style-type: none"> ➤ High-quality feeder high schools ➤ Willingness to educate teachers and trainers in mechatronics 	<ul style="list-style-type: none"> ➤ Weakness in K-12 math and science education; Weak performance on core skills; Poor popular image of apprenticeships in the US
KE 9. Key issues to ensure labour market relevance	<ul style="list-style-type: none"> ➤ Recognized industry leaders guarantee “employability” or graduates ➤ Internationally recognized apprenticeship certificates 	<ul style="list-style-type: none"> ➤ Insufficient collective sharing of costs for sectoral competitiveness

Key Element (KE) of Quality Apprenticeship	Findings from 3 case studies	
	Strengths	Weaknesses/Opportunities
KE 10. A good career guidance-apprenticeship relationship	<i>None identified</i>	<ul style="list-style-type: none"> ↘ Exclusive focus in career guidance on sending students to college ↘ No state-wide or national youth apprenticeship system
KE 11. Improving skills through apprenticeships	<ul style="list-style-type: none"> ↘ Integration of theory and practice ↘ Improving the skills of teachers in community and technical colleges 	<ul style="list-style-type: none"> ↘ Programmes so far limited to German firms in US investments; No involvement of trade unions
KE 12. An active role of business and labour organizations	<ul style="list-style-type: none"> ↘ Collective action to develop high skilled apprenticeship programmes, including in core skills 	<ul style="list-style-type: none"> ↘ Programmes so far limited to German firms' US investments ↘ No involvement of trade unions
KE 13. Apprenticeships and the informal, unorganized sector	<i>Not applicable</i>	<i>Not applicable</i>
KE 14. Encouraging entrepreneurship through apprenticeships	<ul style="list-style-type: none"> ↘ Graduates can work as independent contractors for their current firms 	<ul style="list-style-type: none"> ↘ Entrepreneurship education still needs to become an integral part of the programme
KE 15. Promoting domestic follow-up of apprenticeship programmes	<ul style="list-style-type: none"> ↘ US Department of Labour and Department of Education are developing youth apprenticeship policy guidelines and strategy 	<ul style="list-style-type: none"> ↘ No formal domestic follow-up on the parts of other US states and cities
KE 16. Other key elements	<ul style="list-style-type: none"> ↘ Numerous requests for information from other states; Programme can be a stepping stone toward a four-year university degree in engineering 	<ul style="list-style-type: none"> ↘ Programme does not extend to suppliers to the three companies

Forthcoming: www.skillsforemployment.org

Introduction

Background information

The skills gaps in the U.S. have prompted German manufacturers to develop localized versions of their “dual system apprenticeship programme” in their advanced manufacturing plants in the states of Tennessee, North and South Carolina. According to a 2012 Wall Street Journal article, Germany’s transplant-factories aren’t just cranking out cars, machinery and chemicals. They are also bringing a German training system that could help narrow America’s skilled labour gap. VW, BMW and Siemens have introduced training that combines German-style apprenticeships and technical education at area Community Colleges to train apprentices in mechatronics, an interdisciplinary area of engineering that combines mechanical and electrical engineering with a high amount of computer system and software knowledge. Examples of mechatronic systems are robots, digitally controlled combustion engines, machine tools with self-adaptive components, contact-free magnetic bearings, automated guided vehicles.¹

The German type apprentice programmes are winning adherents as U.S. manufacturers grapple with a paradox: Though unemployment remains stuck above 8 per cent, companies can’t find enough machinists, robotics specialists and other highly skilled workers to maintain their factory floors. An estimated 600,000 skilled, middle-class manufacturing jobs remain unfilled nationwide, even as millions of Americans search for work.²

“In the U.S. we’ve evolved to the point where we think the only thing people should strive for is a four-year college education, and factory work is seen as dirty, dangerous and repetitive,” according to Tom Duesterberg, director of the Aspen Institute’s Manufacturing and Society programme. “In Germany, the work that is done on the factory floor and prepared by its vocational education system is highly valued”.³

In Germany, two-thirds of the country’s workers are trained through partnerships among companies, technical schools and trade guilds. Last year, German companies took on and trained nearly 600,000 paid apprentices. In the U.S., such close cooperation doesn’t often exist. One stumbling block has been companies’ fear of spending on training, only to see apprentices go elsewhere.⁴

Purpose of the case studies

The purpose of these case studies is to examine and document the quality apprenticeship programmes developed by VW, BMW, and Siemens, German firms operating advanced manufacturing plants in Tennessee, North and South Carolina. The case studies are structured to answer a set of questions posed by the ILO about the recent high skills apprenticeships in the U.S. introduced by German firms. In addition to a short background section on each of the three firms, the ILO wanted to:

- Examine the effectiveness of the apprenticeship programme in terms of closing skills gaps, decent work, providing viable career pathways from the point of view of the company(ies), of students, and participating community and technical colleges.

¹ Wall Street Journal available online at: <http://online.wsj.com/article/SB10001424052702303665904577452521454725242.html>

² Ibid.

³ Ibid.

⁴ Ibid.

- Document the aspect of Public and Private Partnerships (PPP) between companies and educational institutions.
- Examine what type of skills do employers consider most important for the young apprentices to learn.
- Determine to what extent were these skills lacking among the training providers such as the local training institutions and how the local training institutions are modifying their programmes.
- Understand how training costs are financed at the colleges and companies and the state or local community.
- Document the process of setting up quality apprenticeships in the southern part of the U.S. and answer the question whether apprenticeship is an employer or an enterprise system and to what extent it is a much broader system of social dialogue.
- Determine what lessons can be learned from this initiative when starting new quality apprenticeships in other US states, such as Maine, Massachusetts, Michigan, and Ohio.
- Obtain additional data if available, such as the:
 - number of apprentices per 1,000 employed persons in the three German plants/by gender;
 - apprenticeship wage as share of skilled workers' wage by/sex;
 - duration of apprenticeship/ by sex;
 - share of graduates that are in employment one to two years after completion of apprenticeships/by sex.
- Understand the economic arguments for the functioning of apprenticeships.
- Develop conclusions and lessons learned on strengthening apprenticeship systems.

Methodology used for each case study

The case studies are based on:

- A review of the literature, including extensive local, national and international media coverage of German firms doing apprenticeships in the U.S.
- Interviews with programme leaders, supervisors, trainers and young apprentices.
- Interviews with company officials, and company leaders who are responsible for training apprentices, from HR departments, with representatives from employment services and in career guidance.
- Interviews with teachers and directors from secondary education institutions and from community colleges.
- Field visits in schools, companies, employment services and others.
- Interviews with US Federal Government leaders in vocational and technical education and labor.
- Interviews with State officials.

Short introduction on the author

Monika Aring is a recognized expert on the policies, programmes and partnerships that build a skilled workforce for sustainable economic growth. Ms. Aring has worked in 42 countries and speaks five languages. A graduate of Harvard University's Kennedy School of Government, Aring has worked at the CEO levels, building strategic partnerships with Fortune 100 corporations, business associations, and donor organizations such as UNESCO, the ILO, the World Bank, the IADB, ADB, and bilateral aid agencies such as U.S. Agency for International Development and the SIDA. Aring is highly skilled in facilitating public/private sector partnerships that help multi-stakeholders develop a shared view of current and future skill needs and what strategies will best support their development. Aring has led projects for developing national skill standards, improving learning at work for high performance companies, better transitions from school to work, lifelong learning, and what it takes to have an effective system to grow better skills and jobs. She has developed and led rapid assessment programmes in many parts of the world. A highly effective team leader, she has led multi-country stakeholder forums in Latin America, Africa, and India, and trained USAID and other donors on how to build more strategic partnerships with the private sector. She has worked in all types of countries – from highly developed to developing, including a learning partnership with firms like Microsoft, First Data, and Whirlpool to learn how to identify new markets and opportunities for strategic partnerships in low-income countries. Her work has been published internationally and featured in the Journal of the Society for International Development, International Herald Tribune, National Public Radio, Fortune Magazine, Training Magazine, New York and Los Angeles Times, and various technical articles and books.

Chapter 1: Siemens experience

Siemens (Youth) Quality High Skills Apprenticeship Programme at a glance

The Siemens (youth) apprenticeship programme pays students for 40 hours per week even though they train in the factory for only 24 hours per week and attend community college for approximately 16 hours per week over a period of three years. This allocation of time is similar to the German dual system where students spend three days per week learning in the workplace and two days per week learning in school. In the Siemens programme students are recruited during their junior year of high school. If they pass Siemens' entrance requirements they may participate in a six-week paid internship at the plant during the summer before their senior year. If selected, they are offered an apprenticeship position in the mechatronics programme that gives students knowledge and hands-on training in the mechanics, electronics, software, computers, robotics used in automation systems driven by PLCs – Programmable Logic Control Systems for which Siemens is the global leader. Students receive international certifications and an Associate's Degree that is transferable to different four-year Engineering degrees.

The Siemens Energy plant in Charlotte has received an extraordinary amount of media coverage for its (youth) apprentice programme in mechatronics, including two mentions by President Obama during his 2012 and 2013 State of the Union Address, various YouTube videos, NPR stories, a Slate article, a National Journal article, a CNN report, a Wall Street Journal article, and numerous articles in regional and local media.

German apprenticeship programmes in the Charlotte, NC area

According to the Director of Learning at Central Piedmont Community College (CPCC), Richard Zollinger, the need to close skills gaps, a shared cultural/economic background of investing in training, and the looming retirement of a high skills workforce in the Charlotte region are reasons why German firms are investing in this apprenticeship programme. "If we don't fix the talent pipeline in the next two to three years we will have a big problem. For example, 39 per cent of Duke Energy's Engineering workforce will retire in four years."

In 2000, seven Charlotte firms took the lead in closing their skills gaps when Blum, a Charlotte-based German manufacturer of high-end hinge, lift, and drawer systems for kitchens, created Apprenticeship 2000⁵, a collaborative of mostly German companies who recruit juniors and seniors from local high schools to participate in a four-year technical training apprenticeship programme in the Charlotte, NC area. A more recent consortium of companies, called Apprenticeship Charlotte, was created to meet increasing demand for apprenticeship programmes and has multiple entry points for veterans, high school students, and others. Both consortia follow a similar curriculum.

"What Siemens is most famous for is that we are not just one of the most global companies but one of the most innovative industrial companies. Every day around the world we develop 20 patents and 40 inventions, so a skilled labor force is hugely important. What we are exporting to key markets is the German apprentice system. We work closely with community colleges to bring them in to work, they are trained, get a degree. Here we have successfully implemented this with the mechatronics (associates) degree they would get at the end of the education. That's how we build our own labor force, engaging young people early on in their professional life and then training them on the equipment that we are using right here in the manufacturing environment."

(Charlotte Observer interview with CEO Peter Löscher, 2/2/12)

⁵ Information available online at: <http://apprenticeship2000.com>

Background of Firm - Siemens

Siemens is a global corporation producing goods in automation, building technologies; drive technologies, energy, healthcare, lighting, mobility, consumer products and various services, including financial services.⁶ In the U.S., Siemens employs 60,000 people, making it one of the largest employers in the nation. The Charlotte facility is the largest in the world, producing all three main power-producing products used by central station power producing Generators, Steam Turbines and Gas Turbines.⁷ The Charlotte plant employs 1,400 workers “as part of a net-centric approach in which the plant’s operations are integrated with Siemens global network of manufacturing centers. These centers include 350 parts suppliers and employ 3,000 engineers. The Siemens apprenticeship programme pays workers as they train and attend school and community college”.⁸

The Siemens Energy plant covers 1 million square feet and 468 acres. Originally built in 1969 by Westinghouse to make low pressure turbines for nuclear power plants, the plant was acquired in 1999 by Siemens to produce electrical generators and steam turbines. In 2010 the plant expanded by 400,000 square feet to include the production of gas turbines,⁹ considered more cost and energy efficient. According to State officials, tens of thousands of people applied for the 750 available positions. Siemens turbines are used for power producers and users, as well as to transport oil and gas, and marine applications.¹⁰

The Siemens (youth) Apprenticeship Mechatronics Programme gives students knowledge and hands-on training in the mechanics, electronics, software, computers, robotics used in automation systems driven by PLCs – Programmable Logic Control Systems. As in the case of producing cars at VW and BMW, a high degree of competence in mechatronics is critical for Siemens Energy as the plant uses programmable logic control systems (PLCs) to produce turbines and generators. PLCs are considered the “workhorse” of industrial automation.¹¹

Siemens Energy is the model for Siemens North America in terms of quality and high skills apprenticeships for youth and adults, such as returning veterans. The other Siemens plants in the U.S. do not have similar apprenticeships for young people. Reasons include a major expansion in March 2010 when Siemens needed to hire 750 people and add 500,000 square feet of space. Siemens’ need for high skills is compounded by several factors, such as very low turnover (less than 2 per cent) and age attrition over the next few years. The team who oversaw the expansion in 2010 firmly believed in apprenticeship training. As a result, Siemens developed a strategic plan to fill those positions. According to Siemens, company leaders had to convince their German bosses that the U.S. is a competitive location for manufacturing, name building and the workforce. An investment in training on the part of North Carolina, as well as the quality of the existing workforce, were essential factors for locating the plant in N.C., as Siemens was first considering India as a location for this plant. The fact that this plant was placed in the U.S. is considered quite a coup by U.S. staff interviewed, who added that senior management recognized that investment in the workforce is critical (CPCC officials). Siemens-Charlotte joined the Apprenticeship 2000 programme in 2011 and now spends approximately \$165,000 (\$4500 per month) per apprentice for its new three-year mechatronics training programme in Charlotte.

⁶ Information available online at: <http://www.siemens.com/entry/cc/en/>

⁷ Information available online at: <http://www.siemens.com/press//pool/de/biographien/2011/biography-pringle-e.pdf>

⁸ Ibid.

⁹ Information available online at: <http://www.energy.siemens.com/us/en/charlotte/about-charlotte.htm>

¹⁰ Siemens Energy Brochure available online at: <http://www.energy.siemens.com/hq/en/power-generation/gas-turbines/>

¹¹ A PLC is used to time, control, and regulate the sequence. Examples that use PLCs include metal machining, product assembly lines, and batch chemical processes. When PLCs first appeared they were hard-wired which made them inflexible. Now that micro-computers are embedded in PLCs they are considered a “robust, reliable instrument capable of running an entire factory automation systems. (Vernon, James: control systems principles.co.uk, Programmable Logic Control.)

Background of the Region

When North Carolina was competing with other countries and states for the new gas turbine division in Charlotte, the quality of the incumbent work force at Siemens and the available workforce in the region were important factors in winning the competition. Another consideration in favour of Siemens-Charlotte was the ability of CPCC to train 750 new workers, and incumbent workers, in a short period of time.

The Charlotte Chamber of Commerce states that Charlotte is one of the most business-focused cities in the U.S., selected by Site Selection magazine as first on its list of top 10 U.S. cities for foreign investment. More than 274 of Fortune's top 500 companies have one or more facilities within Mecklenburg County. More than one third of the 1,156 manufacturing firms in Mecklenburg County are involved with either importing or exporting goods.¹² Among the many factors that influence why international companies come to Charlotte, state-funded worker training programmes are one of the reasons. German companies make up the largest percentage (approximately 20 per cent) of the 950 foreign owned firms (192) and employ over 2,800 people.¹³ The Charlotte-Mecklenburg School system operates five language immersion schools to learn German, French, Japanese, Mandarin, or Spanish. Charlotte recently ranked as America's fifth most literate city based on the percentage of residents having a high school diploma or greater and the percentage of residents with a bachelor's degree.¹⁴ Siemens Charlotte considers Charlotte's Olympic High School as a good 'feeder school', in part because of the school's STEM magnet programme and the extraordinary willingness to collaborate with Siemens.¹⁵

Effectiveness of the apprenticeship programme

Supplying Siemens with qualified applicants/students

Siemens leaders interviewed state that the programme is "very effective in terms of supplying them with quality applicants whose skills are transferable to anywhere in the world". Company officials state that the programme has become very competitive to get into for all seven companies in the Apprenticeship 2000 Programme. In 2013, 168 high school students expressed an interest in the full programme. By the end of the programme the young apprentices have deep experience in mechanical, electrical and electronics components of the programme. This is important in the following way: at the present time, if a machine is not running, Siemens has to call an electrician, a mechanic, and an electronics technician to troubleshoot the problem. But Siemens hopes that in five years from now they will just need to call one of their apprentices. For example, recently, when a machine failed and five experts tried to discover why, a second year apprentice in the programme solved the problem. The training programme is considered so effective that one of the participating firms is sending their graduates as service technicians all around the world. Siemens Energy officials also pointed out that their graduates will be extremely employable and eligible to work anywhere in the world, though Siemens hopes it will be in their own factories.¹⁶ What Siemens calls its "cognitive apprenticeship" programme also brings teachers into the factory so they can learn themselves what the students are learning.¹⁷

Number of (youth) quality apprentices

At the time of the interview (January 2013) Siemens Energy is training 15 young apprentices; 12 are in the mechatronics technician programme and three are studying mechatronics maintenance.

¹² Information available online at: <http://charlottechamber.com/international/an-international-city/>

¹³ Ibid.

¹⁴ Ibid.

¹⁵ Charlotte-Mecklenburg Schools, information available online at: <http://www.cms.k12.nc.us/cmsdepartments/ci/MagnetPrograms/Pages/default.aspx>

¹⁶ Video available online at: <http://www.youtube.com/watch?v=CP3HSfxbKD8>

¹⁷ Video available online at: http://www.youtube.com/watch?v=zjFN_sIPXeQ

Six of them started in 2011 and another six in 2012; and those studying mechatronics maintenance started in January 2012.

Does the programme provide decent work and viable career pathways?

Interviews with CPCC officials and trainers, Siemens officials and trainers, as well as with students, indicate that this programme provides highly flexible career pathways and directly leads to well-paying living wage jobs, anywhere in the world at the end of the apprenticeship.

For example, Siemens, as well as all the other companies in the Apprenticeship 2000 network, promise to hire students if they pass the test at the end of the programme. However students have to go through the formal job bid process. When asked if the promise to hire might change in the future, company officials stated, “we’re deeply committed. There’s always a need for highly skilled people. In 12 months we’re going to make a brand new model generator, we will need new skills.” Each of the young apprentices interviewed report high degrees of happiness with the programme.

Skills Youth Apprentices say are important for success at work

Communication “you have to communicate with engineers and other workers, and you have to figure out what they’re thinking”.

Knowing how to use your tools and how to measure them. “Tools have a certain feel to them that you have to develop over time. Measuring is second on the list –metrology”.

Teamwork “make recommendations on how to improve quality in the mfg. process to improve productivity. Working on a team is something”.

Read C&C language, G codes and M codes. “When we do a service job we have to write our own programme for servicing any rotor or jack shaft”.

Trouble shooting: “If we run into an issue on a lathe we call in a machinist or an engineer”.

At completion of the three-year apprenticeship at Siemens students are offered a job, which Siemens hope they will take.

Key Apprenticeship Programme Components:

- **Associate’s Degree:** an Associate’s Degree in mechatronics, and their courses are transferable for a four-year degree at NC State and University of North Carolina at Charlotte (UNC Charlotte).
- **Recognized Certification:** Siemens Mechatronics Certificate and the N.C. Department of Labor now have mechatronics approved as a certification.
- **Job Functions:** troubleshoot and maintenance of industrial plant processes.
- **Job Titles:** Machinist, Operator, Engineering Technician, Materials Technician, Maintenance Technician.

In the event a student wants to continue his or her studies they can work full time at Siemens while continuing their education to earn a four-year degree in engineering. Siemens will reimburse the student for the education provided their grade point average (GPA)¹⁸ is above 2.5.

¹⁸ GPA or grade point average is a measure of scholastic attainment computed by dividing the total number of grade points received by the total number of credits of hours of course work taken The top grade, A= 4 points, a B=3, C=2 and D=1 point, respectively. Information available online at: <http://dictionary.reference.com/browse/grade+point+average>.

What skills does Siemens consider as most important?

Technical skills

The three-year apprenticeship programme is designed to help youth apprentices develop skills in all the elements of the mechatronics curriculum they learn at Central Piedmont and then apply at Siemens Energy. At the Siemens plant apprentices are supervised by designated instructors who provide hands-on learning opportunities. Instructors at CPCC have been sent to Germany for training, and the College uses state-of-the-art machines in their training rooms.

The Training Manager for Siemens Charlotte Energy Hub considers the following skills as critical:

- Critical thinking.
- Problem solving.
- Collaboration.
- Teamwork.
- Communication skills.

“You can teach the theoretical part at the Community College but you have to put kids in the right setting in the right context. Contextual learning is huge!” (Training Manager)

Public Private Partnership between Siemens and Central Piedmont Community College and the State of NC

Breadth and depth of partnership

Siemens leaders interviewed state: “We’ve been at the table with CPCC from the beginning when it came to training. Siemens leadership team drove the apprenticeship approach. Apprenticeship 2000 provided an existing structure”.

The two-year-old (youth) apprenticeship programme stands on a 13 year long relationship CPCC has with Siemens, and is one among a number of programmes Siemens conducts in partnership with CPCC. According to company and CPCC interviews, Siemens found a strong partner in CPCC who could quickly ramp up new training programmes. Interviews with CPCC officials indicate that CPCC leaders are highly entrepreneurial, and supported in their efforts by the State Community College system in seeking out various sources of funding, such as state-of-the-art equipment in college laboratories and sending instructors to Germany to support the (youth) apprenticeship programme. Beside the apprenticeship programmes at Siemens, CPCC has also trained the company’s hourly workers and developed orientation programmes for company engineers. CPCC officials appear to be full partners with Siemens, who (almost) consider the college as their training department.

State-of-the-art equipment and college instructors trained in Germany

CPCC and State Community College Board officials point out that the equipment for training at the CPCC Training Facility is comparable to what is available at the Siemens plant, thanks to grants from Duke Energy and the State Department of Labor. Moreover, the NCCC system makes funding available to send faculty to Germany to learn how to operate the machines, to learn about mechatronics, and to obtain a Siemens global certification in mechatronics. According to college official interviewed, CPCC ensures that FT and adjunct faculty possess the current Siemens technology skills, certification, and that they transfer that technology to curriculum, continuing the education of the students, as well as Siemens’ employees.

*Partnership with IHK-Karlsruhe, a German regional Chamber of Industry and Commerce*¹⁹

A new and recently formalized partnership with IHK Karlsruhe (August 2012) makes CPCC the first U.S. community college to offer IHK-certified job-training programmes. Students are able to earn IHK-endorsed certificates in five engineering programmes, making them more attractive to German companies in the Charlotte region. The five certifications include CNC Technology, Energy Management, Mechatronics, PLC Technology and Pneumatics (compressed air) Technology. In most cases, students will be able to earn IHK certification in one semester. According to CPCC administrators, these programmes will match job training in Germany so closely that a student could start his/her studies in Germany and complete them at CPCC or vice-versa.

The five IHK certificate programmes will fall under CPCC's STEM-S (Science, Technology, Engineering, Math and Sustainability) division. According to U.S. Department of Labor statistics, workers with STEM-S education and training earn about 70 per cent more than the national average of all occupations. Between 2004 and 2014, employers are expected to hire about 2.5 million STEM-S workers who are entering their occupation for the first time (CPCC website).

Dr. Tony Zeiss, head of Charlotte's Chamber of Commerce and co-signer of the agreement believes that this agreement lets European, and particularly German companies know that Charlotte can provide a workforce trained to their exact specifications, giving the region and its students' competitive advantages.²⁰

Financing

A shared investment on the part of employers, government, State education authorities, trade unions, the Chambers of Commerce and Industry, trade unions, and young people is a hallmark of Germany's dual system of youth apprenticeship. For the apprenticeship programme in North Carolina, Siemens has been able to leverage resources for the programme from other sources, involving some of the stakeholders. A company brochure states that the Siemens project finance equation (public-private partnership) consists of: 1) an Ex-Im bank loan²¹ to Saudi Arabia which increases purchases in NC by \$638 million, 2) a NC Job Development Grants and 3) One North Carolina Fund of \$21 million, 4) a Siemens investment of \$350 million, 5) UNC Charlotte investment of \$76 million and 6) an unspecified investment on the part of Piedmont Community College. In the same company brochure describing Siemens' public-private partnership model in Charlotte, Siemens states that federal, state and local aid plus private financing plus non-profit aid should be considered as a generic formula for success in public private partnerships of this type.

Siemens

Siemens pays students from 9-14.75 an hour as if they were working full time (40 hours a week). However students actually only train at Siemens for 24 hours per week, and then spend about 16 hours per week at CPCC.

- Siemens reimburses students their CPCC tuition costs, provided they keep a 2.8 GPA.
- Siemens calculates that the company spends approximately \$165,000 per student over the entire apprenticeship period of three years. This includes wages, uniforms, schooling, books and specialized on-site training.
- Additionally, Siemens pays the State \$50 per year to register the students with the Department of Labor.

¹⁹ Information available online at: <http://www.cpcc.edu/news/cpcc-signs-training-agreement-with-german-chamber-2013-ihk-karlsruhe>

²⁰ Ibid.

²¹ Information available online at: <http://www.exim.gov>

CPCC

- According to the interviews with college officials, the state legislature supports CPCC's partnership with annual funding to support incumbent workers in the State's industries.
- Siemens considers CPCC as a valuable part of its Training Division, assisting the company throughout the recruitment, selection and assessment process required for adding 750 new workers in a short time and providing apprentices with the education that is part of their programme.
- CPCC is supporting the articulation agreement with IHK-Karlsruhe so that CPCC students can earn the IHK-endorsed certificates in five programmes.

State of NC

- The State's Workforce Development Board built a portal for the application and selection for people who wanted to work at Siemens.
- The State funds in part the acquisition of state-of-the-art equipment for the laboratory based instruction at CPCC for apprentices.
- The State funds in part the costs for sending instructors to Germany for training and certification in mechatronics.
- The State has funded a Math Emporium – a whole new building with 264 computers so students can get individualized math instruction, using occupational math tracks²² required for STEM-based businesses in the area.

Process of setting up apprenticeships

Siemens and the 27 companies in the Apprentice Employer Collaborative have developed a broad system that involves social dialogue among all the partners. The 28 companies have a shared process for setting up apprenticeships; they go through an extensive recruiting phase in October at local high schools with the other German companies. Siemens recruits along with other German firms in the area, targeting high schools of the area. In December the firms hold an Open House and parents and students tour the three companies during a Saturday. Interested students are asked to submit a transcript, looking for a minimum of 2.5 GPA, math scores, attendance records, and teacher recommendations. In February selected applicants go through a four hours late afternoon orientation and testing phase where they are tested for technical math, precision measurement, hand filing (metal) and assembling, and are asked to read a blue print, and do a 3-D drawing. They also take a PSI²³ test to measure mechanical aptitude. Then in March, the 28 partner companies meet and they decide which students go where. In the case of Siemens, in 2013, new students will not be selected for mechatronics/engineering but only for the non-destructive Metal programme.²⁴ This type of programme requires deep analysis and troubleshooting of metal applications.

Qualified high school students who have passed all the tests will first be placed in a six-week paid internship at Siemens during the summer before their senior year. They will work 40 hours per week, starting at 8 a.m. every week day. Some students select themselves out at this point explains the Training Manager, adding, "I invited 12 and kept six," she explains. The internship

²² The Occupational Math website states that occupational math is designed to prepare students for the real world of work. This class engages students in the attainment of functional math concepts that they will need for employment and independent living including: numerical concepts, decimals, fractions, basic geometric concepts, basic calculator skills, budgeting, and banking skills. More information available online at: <http://jobskillsmath.tripod.com>

²³ Information available online at: <https://candidate.psiexams.com/>

²⁴ Nondestructive material testing with ultrasonic equipment has become a classical test method based on measurements with due regard to all the important influencing factors. It is more than 40 years old and has become a classical test method based on measurements with due regard to all the important influencing factors. Information available at: <http://www.keytometals.com/page.aspx?ID=CheckArticle&site=kts&NM=229>

gives Siemens a chance to check out the students. If they show good potential, students are offered the formal apprenticeship, which starts in August, at Central Piedmont Community College.

Key Success Factors

The key success factors of this partnership are the ways in which each partner gains by investing in the (youth) high skills apprenticeship programme. Outstanding factors in this case include the fact that Siemens' investment of time, training, and materials demonstrates that they view apprentices as assets to be developed as opposed to costs to be minimized. Key success factors in this case include the fact that 1) 27 other German firms have worked together in terms of building the programme and creating environment that is attractive to German firms looking for a high skills workforce; 2) Siemens is willing to invest substantial resources into the (youth) apprenticeship programme, 3) the commitment, vision, and entrepreneurial leadership of CPCC's team who continually seek out funding sources to support their partnership, and 4) the strong support of the State and City.

What Siemens gains

- **Global competitiveness because of a highly skilled workforce:** The stakes are high for the Charlotte Energy plant, one of Siemens' global centres of activities. Peter Löscher, CEO of Siemens AG, points out that during a 2012 interview with the Charlotte Observer, "40 per cent of this plant is going to be dedicated to the export market. We've made a major commitment with \$350 million, and now we have to prove that we really are successful and that this group is really now delivering. We have the capacity that we need, but what it really means is that we intend to further grow the employment base here. We're bringing over the apprentice programme from Germany, and I think we can show that we can be competitive here with anywhere in the world".²⁵
- **Ability to innovate and generate new patents, knowledge:** As mentioned previously, Siemens believes its future economic performance depends on its ability to generate new patents, which in turn depends on a highly skilled workforce.
- **Access to external training resources:** Siemens gains significantly from its deep and extensive partnership with CPCC. Siemens' Training Manager and other leaders at Siemens consider CPCC as their training division, stating that if Siemens were located in Germany, they would have to carry an additional 30 trainers on their payroll to do the same work they are doing.

What CPCC gains

- **Additional students and their tuition fees** since Siemens pays for students' tuition.
- **Access to state-of-the-art knowledge, tools, equipment, and resources to one of the world's leading engineering companies.** This helps CPCC be a state-of-the art education institution and therefore be more competitive.
- **Ability to leverage the Siemens' and other firms' investment to enhance or build international partnerships.** For example, the new partnership with Germany's IHK provides the college with access to internationally recognized certification so that students with these certificates can work in Germany. German companies also feel secure that they can hire U.S. students who have these certificates.
- **The potential of almost 200 additional partnerships with German companies** in the immediate area who have a background of shared understanding about the value of quality apprenticeships, the importance of investing in training at work, and that complex skills should be learned by doing.

²⁵ Information available online at: <http://www.charlotteobserver.com/2012/02/22/3034040/siemens-has-high-hopes-for-its.html#storylink=cpy>

- **Leveraging additional resources from the State and City** because of the existing investments in partnerships with Siemens and other German companies in the area.

What the surrounding firms in the apprenticeship programmes gain

- **Additional resources** from the State of NC, its general assembly, and community college board to partner with companies such as Siemens and others so that the companies have what they need to be competitive and grow their business.
- **A network of support for (youth) high skills apprenticeships** thanks to the leadership of other German firms in forming Apprenticeship 2000 and Apprenticeship Charlotte. Both programmes together now include 28 member companies.
- **Access to highly skilled new entrants into their firms.** Within the next few years close to 40 per cent of the region's highly skilled workforce will retire. By jointly investing in training through these partnerships, the firms all gain access to highly skilled entrants.
- **Certainty that apprentice skills levels upon completion correspond to internationally recognized certificates in mechatronics.** As the global leader in PLCs, Siemens serves as the standard-setter for mechatronics. Apprenticeship graduates with internationally recognized certificates in mechatronics can be relied upon to solve complex mechatronics problems accurately the first time, thus saving the enterprise time and money.

What apprentice-students gain

- **Hands-on Learning from state-of-the-art trainers and with state-of-the-art equipment on all parts of the plant.** Students are rotated through all parts of the plant, where they work/learn hands-on with a trainer responsible for training in each area.
- **Mentorship and role models.** Each student also has a mentor who stays with him throughout the two years. One student explains, *"I work with two different people every time. They teach me things I can't learn from a book. We get moved around weekly. We learn to be more versatile"*.
- **Highly transportable skills, certifications and degrees.** As the global leader in PLCs, Siemens serves as the standard-setter for mechatronics.
- **Highly effective learning tools and resources,** such as:
 - *Community College and Siemens trainers trained to Siemens global standard setting specifications.*
 - *Binders to document learning.* Students in the apprenticeship programme have binders with tasks they have to sign off on with mentors and trainers to assure they've mastered them. *"One little mistake could cost lots of money, we learn how to reduce costs. If you can do something with one tool instead of three it saves lots of money. In our binder we document our learning."*
 - *Intelligent use of "testing."* Managers ask the students to explain what they're doing. They test the students at the end of the week on a machine; students have to recall to the instructor what they have learned.

Lessons learned

When asked, Siemens and CPCC leaders think that the following are the most important lessons to be learned from their (youth) apprenticeship programme:

- **Reaching down into the region's human capital supply chain by addressing the important lack of math foundation skills.** Central Piedmont Community College officials talked about the "math problem" in middle and high schools. They point out that 76 per cent of graduates need math

remediation. For Charlotte that means 12,000 students. As a result, “we started looking at how we do developmental math in our remediation programmes at the College since less than 5 per cent of students taking the first developmental math course make it into the regular math course” (CPCC interview). Central Piedmont redesigned its developmental math, using West Virginia’s modularized form of instruction that lets instructors diagnose specific gaps in knowledge and ability. Students use self-paced open laboratories to bring their math skills up to speed. As mentioned before, CPCC believes in this approach so much that they have dedicated an entire building with 264 computers – a math emporium so students get individualized math training. This programme is being implemented state-wide in the autumn of 2013. After officials asked Siemens what kind of math was needed, the College decided to replace Carnegie based (time in seat) approaches with occupational math tracks. “And all of a sudden you realize there is a track of math that is quantitative, and a track that is qualitative, related to STEM. Now we’re trying to redesign math so it’s tied to what the companies need (CPCC official).

- **The importance of educating High and Middle School teachers who understand how STEM skills are applied in mechatronics at Siemens and other companies.** Siemens and other firms have begun to conduct High School Teacher boot camps. During the 2012 summer, Siemens, along with eight other companies, held a boot camp for 23 Charlotte-Mecklenburg teachers. They plan to double that number for 2013.

Chapter 2: Volkswagen Experience

Purpose of Case Study

The purpose of this case study is to examine and document the Volkswagen Academy for Mechatronics – a two-year old Quality Apprenticeship Programme for youth at VW’s new automobile production plant in Chattanooga, Tennessee. This study is structured to answer a set of questions posed by the ILO about the quality of the recent high skills apprenticeships in the U.S. introduced by German firms.

VW Academy for Mechatronics at a glance

The VW Academy for Mechatronics develops multi-skilled crafts persons who are responsible for keeping the Volkswagen plant operational. The new, three-year training programmes in mechatronics prepare graduates for careers in the Automation Mechatronics Programme (AMP) as well as the Car Mechatronics Programme (CMP). 24 students are selected through a competitive admissions process for each programme. When fully operational, the programme is expected to have 108 apprentices. Each programme offers students a comprehensive learning environment that blends classroom and laboratory instruction with paid, on-the-job training experience in the Volkswagen plant. Graduates receive an Associate’s Degree from Chattanooga State College. The VW Apprenticeship Programme provides viable career pathways within VW and in related industries as both Academy programmes will produce graduates with skills in high demand in engineering and manufacturing industries. As in Germany, Academy graduates can choose between two career pathways: they can go on to university after finishing the programme or they can take the technician pathway. No data was available concerning earnings, however, actual earnings by graduate are reported by the U.S. Department of Labor 2010-2011 Occupational Outlook Handbook as follows: Median annual wages of automotive service technicians and mechanics were \$35,790 in May 2010.²⁶

Volkswagen’s (youth) Apprenticeship Programme in Tennessee: VW Academy for Mechatronics

The VW Academy’s Apprentice programme in mechatronics has received extensive media coverage since the programme’s beginning in 2009 (Times Free Press²⁷, CNN²⁸ and WSJ²⁹). The Volkswagen Academy is a partnership between Chattanooga State Community College (CSCC) and Tennessee’s Technology Center. The VW Academy is considered a “unique educational programme” in the sense that it provides students with knowledge and hands-on training in mechanics, electronics, computers, robotics, and automation systems. Mechatronics technicians are highly skilled and valued employees in all industrial settings. Not only is the programme affordable, but it includes paid on-the-job-training (OJT) at the Volkswagen assembly plant. While no previous college classes are required, the admissions process is competitive. All classes are taught directly at the Volkswagen Academy. Both three-year training programmes in mechatronics prepare graduates for careers in the Automation Mechatronics Programme (AMP) or in the Car Mechatronics Programme (CMP). Students are selected through a competitive admissions process for each programme. Twenty-four

²⁶ Information available online at: <http://www.bls.gov/ooh/installation-maintenance-and-repair/automotive-service-technicians-and-mechanics.htm>

²⁷ Information available online at: <http://www.timesfreepress.com/news/2012/nov/10/Volkswagen-calls-for-more-educated-workforce>

²⁸ Information available online at: <http://www.cnn.com/2012/06/13/opinion/bennett-higher-education/index.html>

²⁹ Information available online at: <http://online.wsj.com/article/SB10001424052702303665904577452521454725242.html>

students are admitted to the AMP each year (12 in the summer and 12 in the fall), while CMP enrolls 12 students each fall. Each programme offers students a comprehensive learning environment that blends classroom and laboratory instruction with paid, on-the-job training experience in the Volkswagen plant.

The focus of the Automation Mechatronics Programme is to develop multi-skilled crafts persons who are responsible for keeping the Volkswagen plant operational. Students receive hands-on-training in mechanical systems, electricity, electronics, and machining, welding and automated systems. The focus of the Car Mechatronics Programme is to develop highly skilled technicians who can diagnose and repair mechanical and electrical issues with the Volkswagen automobiles produced at the Chattanooga plant. In addition CMP students will learn basic techniques of body repair including paintless dent repair. Students in both programmes will have an opportunity to apply what they have learned in classroom and laboratories during their four-semester of paid on-the-job training³⁰. Technicians will most likely work for manufacturing or industrial companies, such as VW and be responsible for preventing and correcting equipment malfunctions. The skills and knowledge gained from mechatronics training could place the technician in a number of specialty jobs related to equipment maintenance, or he/she may oversee a wide variety of maintenance needs³¹.

Background of Volkswagen

Volkswagen's Chattanooga Assembly Plant (or Chattanooga Operations LLC) is an automobile assembly plant in Chattanooga, Tennessee, that was formally inaugurated in May 2011. The new billion dollar plant³² serves as the U.S. production site for the Passat model. The 1,400-acre site, which touts an automobile plant including body shop, paint shop, assembly facility, technical testing center, and a supplier park "was scheduled to employ 3,500 people by the end of 2012".³³ A March 2013 Times Press article suggests that "VW's Chattanooga plant may become the first auto factory in the U.S. to create a European-style works council to represent employees, and such a move could provide a foothold for the United Auto Workers in the South".³⁴

In March 2009, the Volkswagen Group of America announced a "\$5.28 million expansion of its Partners in Education³⁵ programme in Tennessee, the new home of VW's manufacturing operations in the U.S. With this expansion, the partnerships with primary and secondary schools, universities, and a leading national laboratory positively impact students throughout their education. The company website states that VW supports students and teachers from Chattanooga State Community College, Fisk University, Hamilton County Public Schools, Oak Ridge National Laboratory, Tennessee State University, University of Memphis, University of Tennessee – Chattanooga, and University of Tennessee – Knoxville".³⁶

Volkswagen's massive Chattanooga manufacturing plant was built to be as environmentally friendly as possible and appears as No. 11 on the U.S. Environmental Protection Agency's (EPA's) Top 20 on-site list of the largest green power purchasers. According to the company website all manner of energy-saving techniques were employed, and the plant remains the only automotive manufacturing facility to have been awarded Platinum certification by the US Green Building Council's Leadership in Energy and Environmental Design (LEED). Part of what makes the plant so green is that it uses hydroelectric power as much as possible supplemented by solar arrays that

³⁰ Information available online at: <http://www.chattanoogastate.edu/ttc/volkswagen-academy.html>

³¹ Information available online at: <http://www.chattanoogastate.edu/ttc/automation-mechatronics.html>

³² Information available online at: <http://www.volkswagengroupamerica.com/chattanooga>

³³ Information available online at: <http://athome.volkswagengroupamerica.com/growing-jobs/volkswagen-inaugurates-new-chattanooga-plant>

³⁴ Information available online at: <http://www.timesfreepress.com/news/2013/mar/20/3-20-a1-vw-opens-door-to-unionization>

³⁵ Information available online at: http://www.volkswagengroupamerica.com/chattanooga/partners_in_education.html

³⁶ Ibid.

generate more than 13 million kilowatt-hours (kWh) of green power annually. This is enough green power to meet 12 per cent of the organization's electricity use. The Volkswagen Chattanooga Solar Park is the biggest solar installation at any U.S. auto factory and the biggest solar installation in the state of Tennessee.³⁷

Background of the region

Chattanooga was considered the “Rust Belt city of the South”, called the dirtiest city in America in the 1970's. It wasn't only manufacturing that dried up in Chattanooga. As in the rest of the country, construction was down. “Before VW showed up, I spent the last 25 years in the building industry in this area, and it got pretty bad,” according to a team leader at Volkswagen's Chattanooga plant. “Housing development ceased to exist, almost. A lot of people were looking for work.” As far as Chattanooga at that time goes, we had been losing industry rather than gaining anything”. VW's apprenticeship programme in mechatronics suggests that learning a highly complex and interdisciplinary field such as mechatronics can most easily be learned through a combination of theory, practice, and hands-on learning in the context of an advanced manufacturing work environment.³⁸ Unlike Tennessee's Technology Centers one-year technical programme, the VW Apprenticeship Programme (VW Academy) takes three years (nine semesters) to complete.

The reason VW invests in the VW Academy is that it provides the company with a pipeline of individuals who possess the required technical and non-technical skills for future jobs. Moreover, “If we train our students to international competencies, we could use them in China or wherever, which makes us more flexible (interview with VW Trainer). However, according to VW's officials, if the Apprenticeship Programme were expanded to other firms the programme would benefit society in general. Poaching is one reason many U.S. employers give for not investing in training. When asked if there is a concern about the possibility of other firms poaching graduates from VW, company officials stated that if students are successful in completing this programme they can tender the first offer to their graduates.

Effectiveness of the apprenticeship programme

Supplying VW with qualified applicants and closing skills gaps

Company officials point out that they haven't had time to do research on their programme's effectiveness as the programme is just about to graduate its first pool of students who began their training when the plant opened in 2009. “Right now we are drawing on the experience of the skills needs in Germany and are training specific to that,” according to VW's Trainers, who say that they look for raw talent, not specific abilities when assessing applicants for the programme. Applicants must possess a high school degree and a score of 19 or higher on their ACT.³⁹ According to VW officials, everyone who is successful in completing the programme will receive a job offer from VW.

Number of (quality) apprentices

Demand in the community and surrounding states for the VW Apprenticeships is high. Of the 36 per year that VW can accommodate into the programme, hundreds apply. VW's Plant Manager suggests that many U.S. students are channelled into the university path, as parents are reluctant to send their kids to apprenticeship programmes, believing these lead to dead-end and dirty jobs.

³⁷ Information available online at: http://www.volkswagengroupamerica.com/newsroom/2013/02/04_EPA_Recognizes_Volkswagen_Group_of_America_Chattanooga_Operations_LLC_Among_Nation_s_Leading_Green_Power_Users.html

³⁸ John W. Gardner's Center (2010) “Youth in the Middle”, available online at: http://gardnercenter.stanford.edu/docs/YIM_Toolkit_100429.pdf

³⁹ ACT (American College Testing) issues one of two college entrance test used in the U.S. in addition to a wide variety of tests for schools and workplaces, as well as policy documents. Information available online at: <http://www.act.org/>

One of VW's Managers, adds, "when we have an open house people are so surprised because it's so clean here!" Company officials point out that as they ramp up the programme they will have room for more apprentices.

Does the programme provide decent work and viable career pathways?

The VW Academy Apprenticeship Programme provides viable career pathways within VW and in related industries as it produces graduates with skills in high demand in engineering and manufacturing industries. As in Germany, Academy graduates can choose between two career pathways: they can go on to university after finishing the programme or they can accept employment or do both. For example, apprentices who have successfully completed the programme can continue working at VW and earn 36 Academic Credit hours toward an Associate's Degree in Engineering via the programme's partnership with Tennessee Technology Center. Students who complete the Associate's Degree can also get a four-year degree while working at VW. If students are accepted, VW will pay their full tuition at \$10,000 per year and adjust their schedule at the shop to accommodate their school schedule. Called "2+2", this programme had 166 applicants for 12 available positions in 2012.

What skills does VW consider as most important?

Soft skills

The VW officials interviewed agree that soft skills are the most important skills to learn in the programme, and the most challenging to teach in traditional classroom settings.

In the VW Apprentice Programme students learn in teams, acquiring soft skills such as diagnosing and solving problems, internalizing decision trees to find root causes, planning and organizing work, communicating with team members, having habits of mind that support high performance work. During a tour of the factory, for example, the Training Manager points out an apprentice who is learning how to file metal: "This exercise may take several days. It's not about filing. A machine can do that in minutes. It's about gaining a deep appreciation of metal, what it can and cannot do. Understanding its structure, what it needs, how to work with it".

"They lack the pedagogical teaching, how to handle learning for young people in a company setting. It's not sitting in a class with an instructor in front" (VW trainer).

When asked to what extent classroom-based training inhibits learning soft skills, the head of apprentice training mentioned that classroom instructors usually lack the pedagogical training for how to handle young people in a company. "When you deal with young adults you have to engage them. It's not about sitting in front of a class instructing." The Manager of Employee relations elaborates: "the way traditional training providers teach is not geared to learning specific skills, but geared to learning for university. There is not so much applied knowledge. The education system here, primarily the secondary schools, don't have the financial resources to stay on top of the technology that changes day by day. VW's Plant manager elaborates: "What I see missing in the instruction is not so much the techniques but the mind-set of thinking and operating as a business".

To what extent were these skills lacking in local training providers?

According to VW trainers, the local training providers do not teach the skills needed to operate a business, and there is less focus on applied knowledge.

Public Private Partnerships between Volkswagen, Chattanooga State and Tennessee Technology Center

The VW Academy should be seen as a partnership between Chattanooga State, VW, and Tennessee's Technology Center. There are 27 Technology Centers in the State, all function independently except in the case of Chattanooga State, where the Technology Center is a division of the Chattanooga State Community College, whose 13,000 students include 2000 TTC students.

VW officials state they appreciate how the CSCC training providers are willing to listen to VW's requirements and adjust. "CSCC have a good customer mind-set – they allow us to acquire the skills of the instructor base, to adjust the pedagogical training. We're even involved in the selection of those instructors. But this programme is not suitable for all instructors. If you have deep roots in the college system there may be cognitive dissonance. We have really good instructors who have an open mind".

Financing

All three partners invest in the training costs. Although specific information on the size of the investment was not available, the following appears to be the distribution of investments by the three partners:

VW

- Built the Training Center.
- Provides curriculum and skills requirements.
- Maintains quality control of programme.
- Provides scholarships for students.
- Provides books, course materials, uniforms.
- Pays for some of the instructors.
- Pays training wages when students are learning on the job.
- Integrates apprentices into VW team of experts for learning and development.

"We have hands-on tests and written tests that are mostly individually focused on the specific learning needs of the students to see what they need so that we can keep them on board. It's our responsibility to keep these in the programme" (VW Training Manager).

Chattanooga State

- Provides 35 instructors and staff.
- Maintains the Academy's appearance to VW standards.
- Provides financial aid.
- Co-conducts assessment of entrants.
- Improves instructional quality if needed.
- Maintain feedback mechanisms from plant managers.

Tennessee Technology Center

- Provides financial aid.
- Provides expertise to the College.

It is important to point out that the programme is structured so that students should not incur any direct costs for participating in the programme, other than transportation.

Employer Enterprise or broad social dialogue?

The VW Academy appears to be an employer enterprise with limited social dialogue, not organized in terms of labour. The VW Academy should be considered an employer initiative conducted in partnership with the college, the Technology Center, and the State of Tennessee. At this point the VW Academy does not include dialogue with other firms in the area. College officials interviewed for this case study point out that they have strong relationships with industry and other groups, such as the Southern Automotive Association and the Chattanooga Regional Manufacturers Association.

Process of setting up apprenticeships

The VW Academy's Apprenticeship Programme has a clearly defined process for setting up apprenticeships:

1. Student assessment.
2. Interview with VW and Chattanooga State.
3. If accepted, students join the programme at regularly scheduled times (the onboarding process starts with a safety programme, after which the curriculum begins).

Key Success Factors

As in the other case studies, one of the key success factors of this partnership is the fact that each partner gains by investing in the (youth) apprenticeship programme. Outstanding factors in this case include the fact that as in the case of BMW and Siemens, VW's leadership in terms of investment of time, training, and materials demonstrates that they view apprentices as assets to be developed as opposed to costs to be minimized. Key success factors include 1) the integration of State Technology Centers with the Community College and the firm; 2) the structure of the programme as a partnership, 3) the design of the basic training, the expert training and the continuous improvement process.

What VW gains

- **Skills that meet VW's requirements**
- **A pipeline of individuals who possess the required technical and soft skills for future jobs.** VW's Academy helps improve the reputation of advanced manufacturing so as to attract more students – there is enormous demand for machinists and industrial maintenance experts. At this point some people who cannot find jobs even in other states are coming back to retrain for those jobs.
- **International competitiveness of their workforce.**

What Chattanooga State gains

- **Access to an important partnership with a global company such as VW.** "You have to have partners who are willing to bend- what we're offering is different from what we do on the traditional side of the campus. VW had their ideas and we had to blend their ideas with ours and make something that works" (Chattanooga State Officials).

- Lessons from the VW partnership helping other College programmes.** Chattanooga State officials note that what they're learning at VW is spilling over into parts of the college system said some officials from Chattanooga State. "We are able to use VW's high demand for excellence and we're able to use that as a story to tell students about the importance of performing at your best" (Chattanooga State Officials). CSCC has begun a work ethic programme that we are trying to incorporate into every programme, including English, history, psychology; all the general education courses now have a work ethic component. Our relationship with VW and other foreign companies helped us understand the importance of having a work ethic programme (Chattanooga State College Official).

What students gain

- Training for highly transportable skills in high demand**
- Hands-on training from state-of-the-art trainers** from Germany and equipment in all parts of the plant.
- Experiential learning of soft and technical skills.** VW has designed the learning experience so that students learn both soft and technical skills by doing. For example, students are required to spend extended time filing metal to get a hands-on appreciation of how metal responds to different treatments.
- A career path that can lead to direct employment at VW via the technician pathway or the pursuit of an engineering degree.** VW officials point out that if students are successful in getting the Associate's Degree they can get the BA degree while working at VW.
- An Associate's Degree** upon completion of the apprenticeship.

"If you're accepted we will pay 100 per cent of the apprentice's tuition at \$10K a year and adjust their schedule at the shop to accommodate training here. We had 166 applicants for 12 available positions"
(VW Training Manager).

What the State of Tennessee gains

- The higher quality of training may attract other firms to locate in the area.** The overall economy benefits from a higher quality of training and it may attract other firms to locate there.
- The pull of a globally recognized company in making manufacturing careers more attractive.** "One of the greatest issues that we see is that we have great companies here in Chattanooga. We feel we have really designed programmes to meet their needs. The unfortunate part is that we don't have enough students going into these programmes to meet the needs of these companies" (State Economic Development official).

What Lessons can be learned from the VW Academy in setting up other quality apprenticeships?

Leaders at VW and Chattanooga State and Technology Center believe that the following lessons could be learned from this apprenticeship programme:

- The importance of vision and courage:** "It's a 4,000 hour programme leading to an Associate's Degree inside a college that's designed to move people to an academic BA degree. There is a concern about this occupational direction at the state level – fortunately we had the support to do that, the state made changes in approving the programmes" (State officials).
- The need to reach down into the workforce supply chain – the high schools in the area.** "Even high schools are becoming involved as the coordinator of the VW programme goes to

the high schools and makes presentations. We're having lots of discussions with high school counterparts on how to go in before students leave high school. We've developed an excellent relationship with the county school system. We try to coordinate and work together across the board, not just on technical training" (State officials).

- The strong partnership between Chattanooga State, Tennessee Technology Centers and VW.

Chapter 3: BMW Experience

Purpose of Case Study

The purpose of this case study is to examine and document the BMW Scholars Programme – a Quality High Skills Apprenticeship Programme for youth at BMW’s only full automobile production plant in the U.S., located near Spartanburg-Greenville, S.C. BMW’s Scholars programme began in August 2011 and is a partnership with three of South Carolina’s 16 Technical Colleges: Spartanburg Community College (SCC), Tri County Tech (TCT), Greenville Technical College (GTC) and the State of South Carolina.

BMW Scholars Programme at a glance

BMW Scholars Programme teaches/trains 35 Technical College students per year for a two years period in three different tracks: 1) Automotive Technology, 2) ESA (Equipment Services Associate) Robotics/Mechatronics, Industrial Maintenance, Mechanical or Electrical Engineering, Other Related Degrees, and 3) Production: Production Associate Technology, and other related manufacturing fields, such as engineering, welding and machine tools.⁴⁰ Students earn an Associate’s Degree at the same time as they are rotated through all the tracks at BMW. They are offered a job (\$18-23 an hour) upon completion or tuition reimbursement if they want to pursue a four-year engineering degree while working at BMW. The BMW Scholars Programme is part of a network of programmes in South Carolina whose Technical Colleges provide training to industry. The BMW Scholars Programme appears to be unique in terms of the quality and depth of learning at school and in the workplace.

BMW officials interviewed say this programme is in their economic interests because of the limitations of skilled labour in the community’s talent pool, specifically in mechatronics. Like many other German firms, BMW is convinced that you cannot find those people, “you have to build them”. BMW also believes it needs to play a (leadership) role in the community by investing in the community and provide opportunities to the local labour pool (BMW Training Managers)

BMW’s (youth) Apprenticeship Programme in South Carolina

According to BMW officials “Recruitment and retention of a skilled and talented workforce – at all ages and stages of their career – is one of our most important challenges”.⁴¹ The South Carolina plant – BMW’s only automobile production plant in the U.S.- launched the scholars programme in August 2011 and has recruited over 70 Scholars, with another 35 planned to start in September 2013. BMW says that the Scholars programme offers the workplace benefits of a traditional German apprentice programme with the additional advantages of tuition and book assistance. According to Josef Kerscher, the plant’s CEO, “This is a great example of how collaboration between the educational and manufacturing sector leads to far better outcomes for our next generation”.⁴² Like many other German CEO’s, Kerscher went through Germany’s dual system of apprenticeship himself. BMW’s global team considers a number of factors in deciding where to expand and build products. An important aspect they look at is the quality of skills available at a location. The lack of skilled people creates an uneven playing field and affects companies’ ability to compete globally.

⁴⁰ Information available online at: <http://www.sccsc.edu/academics/programs/industrial/BMW>

⁴¹ BMW Scholars Programme Overview, updated September 2012

⁴² Ibid.

Senior managers interviewed speculated that if the CEO had not gone through the dual system, they would not have invested in this comprehensive training system.

Background of BMW⁴³

BMW Group built its first full manufacturing facility outside of Germany in South Carolina in 1992, pledging to invest \$600 million and employ 2,000 associates by the year 2000 and attract nine suppliers to the state. Over the past 19 years, the BMW plant has gone through four major expansions and increased its investment in South Carolina to \$5.8 billion (through the end of 2012). By 2010 the number of on-site workforce, including BMW associates and contract workers grew to about 6,000 with a total payroll of more than \$450 million annually. Since July 2010, BMW has announced another 1,600 jobs and has grown its workforce to about 7,000 people. In 2012, the plant announced that they would hire another 300 in 2012. BMW accounts for more than 28,000 jobs (21,000 in the state and 7,000 at the plant); about 3.2 per cent of the state-wide manufacturing workforce is related to BMW's presence in South Carolina. As of 2007, BMW contributed \$8.8 billion annually to South Carolina economy.

Environmental sustainability is an important part of the plant's operation as BMW uses methane gas coming from a landfill to provide 50 per cent of the energy for its plant. This reduced CO₂ emissions by 92,000 tons per year and has saved BMW an annual average of \$5 million in energy costs. The plant is ranked No. 4 on the U.S. Environment Protection Agency's top 20 list of the largest green power users for 'On Site Generation'. The BMW Group has been named as the automotive industry's Supersector leader⁴⁴ for the eighth consecutive year, and is therefore the world's most sustainable automobile manufacturer. The plant uses new solar panels to provide solar energy to fully power the 24,000 square feet BMW Museum, called Zentrum, and three new electric vehicle-charging stations (available for public use). The BMW plant uses a number of sustainable production technologies, including a hydrogen fuel cell fleet of material handling equipment and integrated paint technology. Overall, since 2006, BMW Manufacturing has decreased water consumption by 51 per cent, energy consumption by 46.9 per cent, air emissions (VOC) by 25.7 per cent, waste disposed of in a landfill by 65.5 per cent and, industrial wastewater by 46.8 per cent.

Background of the Region

Most widely known as the home of BMW Manufacturing, Spartanburg has a 40-year history of attracting global firms. According to the New York Times,⁴⁵ the area boasts the highest per capita international investment in the country. More than 100 international firms representing some 15 countries, including BMW, Michelin, Invista, Adidas, and Magna Intier (Innertech) have found a home in Spartanburg County. According to county publications, the county offers an excellent transportation system, being at the crossroads of two major interstate highways, I-85 and I-26 and two major southeast rail service providers. The county is also the location of Greenville-Spartanburg International Airport, and is only three hours from the Port of Charleston.⁴⁶ Adjacent Greenville County is the most populous county in the state and the centrepiece of a region long considered the 'economic engine of South Carolina'. It has become one of the Southeast's premier areas for business. Over the past 30 years, Greenville County has transformed itself from the Textile Capital

⁴³ Content for this section comes from Appendix 2, BMW publication History of BMW Manufacturing/Workforce Development.

⁴⁴ Semiconductor Automotive Component Electronic Rebuilders (SACER LTD) announces that BMW is named Supersector Leader for the Sixth Consecutive Time, according to the Dow Jones Sustainability Index. Available online at: <http://www.sacer.com.cn/doce/news-detail-339.html>

⁴⁵ The New York Times, available online at: <http://www.nytimes.com/1992/06/23/business/winning-the-game-of-global-smokestack-chasing.html>

⁴⁶ Upstate Alliance Fact Sheet, information available online at: http://www.upstatesalliance.com/regional_overview/index/site_location_center/regional_overview/spartanburg_county/

of the World into a destination for both international and national corporate offices and state-of-the-art manufacturing and warehousing/distribution operations. It is now home to dozens of world-class companies, including General Electric, Michelin, Fluor, Samsung, and Minnesota Mining and Manufacturing Company (3M).⁴⁷

Classes from the Technical Scholar Programme are conducted at the 16 Technical Colleges, located in strategic locations around the state. The Tech Scholar Programme started 30 years ago in participation with companies, such as GE, Michelin, Bosch. “Originally the Tech Scholar Programme was focused on just a few professions, such as tool and die. Advanced Maintenance Production such as Mechatronics did not exist. College leaders report that from the outset BMW insisted that the three area colleges share content, and that other companies could join in. South Carolina considers its Tech College programmes as co-op programmes in that all participating students get paid and “hit the ground running (Greenville Technical College leaders)”. The three Technical Colleges surrounding BMW got together 10 years ago to develop a Mechatronics curriculum. College officials claim that the “integration of instruction with certifications makes our graduates very marketable (BMW plant officials and trainers)”.

South Carolina forecasts a very strong economic outlook over the coming ten years. Plant officials said that: “It’s going to be all skills based versus labour based employment. The retirement of the mature workforce coupled with shrinking numbers of young people means that the region cannot afford to lose students who don’t finish high school”. College officials claim big companies will drive manufacturing. For example, companies such as Michelin, MBW, and Boeing, are bringing their Tier 1 and Tier 2⁴⁸ suppliers within the region. BMW foresees a need for 35 students a year to make up for those employees who will be retiring.

Effectiveness of the apprenticeship programme

Supplying BMW with qualified applicants and closing skills gaps

Company officials unequivocally state that their training programme is highly effective for preparing students for BMW’s (and other advanced manufacturer’s) needs. They point out that students get an Associate’s Degree from one of the Technical Colleges while getting technical training on-site at BMW. For example, students in the ESA track get their fundamentals at the technical college but also get robotics training at BMW. Students in the automotive track are put through specific classes on-site. Students in the production track also learn lean production on-site. According to plant trainers, students gain the necessary soft skills as they shadow them and are asked to troubleshoot and problem solve throughout their training.

BMW allows for specific career goals. “Here if you want to be a robotics expert you get to learn it, if you want to go into management, you get to work with teams. Students I know with history degrees are bagging groceries.” (BMW student interviewees)

Students believe the programme is effective because of the hands-on training, rather than classical education, “where you just sit in a classroom”. According to apprentices interviewed, “It’s nice to learn stuff at school and then go to work and actually see it happening. For example, we learned about cycle times and came in to work and saw cycle times being applied.” “We had team leader classes in school. We work in teams here so we constantly get to apply stuff we learn.” “I have to write a report on robotic welding for class. Right now I’m working 20 feet away from robotic welding at BMW.”

⁴⁷ Ibid.

⁴⁸ The terms indicate the commercial distance in the relationship between the manufacturer and supplier. Although supply tiers can apply to any industry, the terms most commonly describe manufacturer and supplier relationships in the automotive industry. Information available online at: <http://smallbusiness.chron.com/difference-between-tier-1-tier-2-companies-25430.html>

Number of (youth) quality apprentices

Each year BMW selects 35 apprentices for the programme that lasts 18 to 24 months. At any given year there are 70 apprentices in the programme.

Does the programme provide decent work and viable career pathways?

Students are assigned to three different tracks: production (build cars), automotive (service technicians), and ESA (industrial maintenance). The first three months students rotate through the core curriculum at BMW. After, they move into their specialty. They are assigned a mentor and specific supervisors at each station. If students complete the programme satisfactorily they are offered a job at BMW, earning approximately \$35,000 a year. Typically wages starts at \$18 an hour and top out at \$36 an hour for 40 hours of work per week with paid overtime if they want to earn more. Typically a graduate of the BMW Scholars Programme will have:

- Associate's Degree.
- MSSC Certification.
- Job Functions: (according to the three tracks).
- Specific Job Title depending on job offered).

"You feel like you're part of something big. Your skills develop more, you learn how to work with robots, troubleshooting, you could work anywhere. It's such a great feeling." "We get enthusiastic feedback from our supervisors." (BMW Student interviewed)

Career pathways could be made more viable by improved articulation agreements between local engineering universities such as Clemson and the Technical Colleges participating in the BMW Scholars Programme. According to students and instructors interviewed, students who want to go on to a four-year degree in engineering, for example, at Clemson University, cannot transfer credit for technical courses taken in the technical colleges. One student reported that he had to go out of state in order to get credit for his technical coursework. This appears to be an important weakness in the effectiveness of the programme.

What skills does BMW consider as most important?

Technical skills

"Scholars have a list of learning and performance objectives for each area of the plant and know they have to be evaluated at the end of the rotation. The supervisors also know the objectives – the apprentices have to teach back to the supervisor, showing that they know it (BMW trainers)".

"We're introduced into a department and assigned to a trainer and learn and get good in a short time and then we can go back to the supervisor and report that we learned it. We learn with small goals." "You can learn by reading a book but you can't learn how to operate without actually doing it. We get to work with robots. When we make mistakes here they're a learning opportunity for new technical skills." "Independence. When they put you in an area, introduce you to a supervisor or people, it's up to you if you keep pursuing more knowledge, how hard and how fast you work. You can shine if you put your mind to it."
(Interviews with BMW apprentices)

Soft skills

- Teamwork.
- Knowing how to leverage the resources around you.

- ↘ Interviewing.
- ↘ Communication skills.
- ↘ Flexibility.
- ↘ Self-Discipline.
- ↘ Time Management.
- ↘ Self-Awareness.
- ↘ Self-Understanding.
- ↘ Professionalism.
- ↘ Self-Confidence.

Foundational Skills

- ↘ Math: Technical college instructors say that math skills are very important: “They have got to understand math. Everything’s explained with math. You can’t ‘see’ electricity, so you have to calculate. You have to be good with hands, tools. The kids that do really well are kids who love computer games. PLC is a computer that controls a machine. Robots are the same.”

To what extent were these skills lacking in local training providers?

When BMW and other firms came to the area, they talked with the Technical Colleges institutes in order to help them develop a curriculum for Mechatronics. According to a state economic development official, the development of the Mechatronics apprenticeships curriculum at the Technical Colleges and BMW (and other firms) is a good example of the state providing seed money to the colleges to develop a common curriculum.

Public Private Partnerships between BMW and area technical colleges and the State of South Carolina

The BMW Apprenticeship Training Programme (BMW Scholars Programme) should be seen in the context of the on-going Technical Scholars Programme in South Carolina, a programme supported by the State Legislature and that works with a number of other firms in the area. However, The Technical Colleges’ relationship with each firm is a one-on-one relationship, and it is interesting to note that to date there is no attempt by the Technical Colleges or BMW to develop a shared foundation of curricula that applies to all companies using Mechatronics/advanced manufacturing process. Throughout the interviews, officials from BMW, the technical colleges and state policymakers emphasized that their track record of successful collaborations with federal, state and local governments and the private sector has helped transform South Carolina’s economy. For example, BMW talked with state officials about what the state’s automotive cluster needed to remain competitive. The industry said it needed a new kind of engineer — one who understood how all the mechanical, electrical and computer systems in a modern automobile work together. This led to a new automotive engineer curriculum at Clemson University.

Financing

BMW

- ↘ Salary for 10 hours per week (starting at \$10-12.75 and going up to \$20-25 an hour once hired).

- Tuition Assistance of \$1500 per semester.
- Uniforms, safety equipment and, books.
- Trainers in all three tracks.
- MSSC certification.
- Subscription for 'Tooling You' – an e-learning course of 25 hours each year.

"We ask them questions and they have to teach the questions back to us. If they are not able to we work with them to close that gap. All the evaluations are given to them and they know exactly what we'll be asking the whole time. We also conduct classes or BMW training courses during semester breaks. Right now the 49 scholars we have 46 different work schedules, we work around each of their schedules we work days, nights, and evenings here.)" (BMW Training Manager)

Technical Colleges

- Provision of training (however this is reimbursed by BMW).

State of South Carolina

- The State provides a \$1,000 tax credit per year per apprentice to companies.
- According to an interview with a State Legislator, the existing partnership BMW and other firms have with the Technical Colleges help both the companies and students in terms of building a workforce pipeline.

According to BMW leaders interviewed, the programme is structured so that students should not incur any direct costs for participating in the programme, other than transportation.

Involvement of Social Partners, Employer, Enterprise, or broad social dialogue?

The ILO distinguishes between programmes that are driven by one employer, by employers in an industry sector, and programmes that engage a broad social dialogue involving trade unions, government, and employers. The Technical Scholars Programme appears to be an enterprise system because it involves multiple companies who partner with the State's Technical Colleges to prepare students with the skills they will need. According to Technical College leaders, these programmes are considered cooperative learning (co-op) and not apprenticeships. The BMW Scholars Programme more closely resembles an apprenticeship model, since students are sponsored by the company who agrees to train them for specific skilled trades. The company also issues a recognized Certificate at the end of the term, and the apprentices are paid for training.

Process of setting up apprenticeships

BMW and other companies go to high schools and Technical Colleges in the area and recruit from there.

"Once students come into the plant in the fall they have a two-week session for onboarding. Over the next two months they learn the culture of the company and take several training courses. After that students are placed in the production roles in the different parts of the plant. They are introduced to their OJT supervisor. Students go out and work in the various roles during that time. Trainers conduct periodic evaluations – three for each role rotation" (BMW Manager)

What kind of candidates BMW is looking for:

- Strong written and verbal communication skills.
- Ability to work in a team environment.
- Time management and organizational skills.

Steps before getting diploma:

- Apply (resume, transcript with a GPA of 2.8 minimum).
- Testing (written exams and live simulation of manufacturing to test the coordination skills).
- Interviews.
- If selected, onboarding begins with:
 - orientation (two to three weeks);
 - core training;
 - rotation through different stations every two months;
 - testing;
 - certification.
- Associate's Degree.

Key Success Factors

As in the other case studies, one of the key success factors of this partnership is the fact that each partner gains by investing in the (youth) apprenticeship programme. Outstanding factors in this case include the fact that as in the case of VW and Siemens, BMW's leadership in terms of investment of time, training, and materials demonstrates that they view apprentices as assets to be developed as opposed to costs to be minimized. Key success factors include 1) BMW's leadership and vision are counted; 2) the fact that BMW plants compete globally for the opportunity to build cars. Selection depends upon a number of factors, among which costs and capacity are highly dependent on the skills of the workforce; 3) reputation of BMW as a global leader, making it an extremely attractive place to learn and work; 4) the commitment and willingness of the Technical Colleges to work closely with BMW to integrate their education as much as possible with what students learn at BMW and to provide what's needed; 5) the strong support of the State of South Carolina.

"It's nice going to school learning stuff and going to work and actually seeing it happening. For example we learned about cycle times and came in here and saw cycle times being applied..."

"We had team leader classes in school and then we work with teams here, so you apply stuff here that you learned in school..."

"I took manufacturing processes I and another student (a scholar) were given a process, find the cycle time, what could be improved, and went to each station and combined the data and did a report about it". "I was working in the same class, had to report on robotic welding and right now I'm working 20 feet away from robots welding..."

(BMW apprentice interviews)

What BMW gains

- **Ability to compete with other BMW plants around the world** for the opportunity to build cars in the S.C. plant due to the comparable quality of its skills. According to interviews with BMW officials, BMW plants around the world have to compete for the right to build a particular model. BMW's CEO wanted to bring the German apprenticeship programme to South Carolina (the only car producing plant in the U.S.) so that his plant was competing on an equal level.
- **A means of overcoming the limitations of skilled labour** in the local labour pool.
- **Access to the resources of the state's 16 technical colleges and their infrastructures** so they can take advantage of the colleges' laboratories, instructors, knowledge, and experience.
- **A way to reach into the high and middle schools to build interest in technical occupations,** develop STEM skills and develop a pipeline of highly skilled technicians given the increasing need for high-level technical skills in automotive production.

What the Technical Colleges gain

- **Additional students and their tuition fees** since BMW pays for students' tuition.
- **Opportunity to modify their programmes** to correspond to the state-of-the-art productions needs at BMW.
- **Access to state-of-the-art knowledge, tools, equipment, and resources to one of the world's leading automotive companies.** This helps the Colleges be state-of-the-art education institutions and be more competitive.
- **Potential ability to leverage the BMW's and other firms' investment to enhance or build deeper partnerships.** As discussed earlier, a number of advanced manufacturing companies participate in the BMW Scholars Programme. This provides an extraordinary opportunity for the companies to come together and explore a deeper and more shared investment and participation.
- **Potential ability to leverage additional resources,** for example, if there were a deeper integration of the various programmes with different companies in the area.

What apprentices-students gain

- **Hands-on learning from state-of-the-art trainers and with state-of-the-art equipment on all parts of the plant.** Students are rotated through all parts of the plant, where they learn via hands-on experience with a trainer in each area.
- **Experiential learning of soft and technical skills.** BMW has designed the learning experience so that students learn both soft and technical skills by doing. For example, they have to report back what they learned at each station in the plant.
- **Mentorship and role models.** Each student also has dedicated supervisors, instructors, and a mentor who stays with him or her throughout the whole programme.
- **Highly transportable skills, certifications and degrees.** "Our students can work anywhere upon completing the programme."
- **Noticeably higher confidence in their knowledge and skills,** according to Technical College Instructors.
- **Internationally recognized Certifications.** "We're getting certifications that are internationally recognized. I even get to learn during school break with the online tools BMW buys for us."
- Acquisition of an Associate's Degree.

Lessons to be learned

Leaders at BMW and the three Technical Colleges suggest that the following lessons can be learned from this apprenticeship programme:

- There is a “war on talent” and this approach allows BMW and other companies to grow their own talent.⁴⁹
- Collaboration is the key to this programme and others like it. Neither companies nor firms should assume the other party could do it on their own. For example, employers complain that the colleges don’t teach the right things but then they don’t talk with the colleges, or even know what they need.
- It is important to look after the young people being trained in the firm. “Our management team looks after these young people, the same as they look after all the people. We have a close engagement with our associates; Fairness, internal checks and balances. We would not consider any discipline without consulting the Associates Relations Group (internal group at BMW in charge of employee relations issues)”.
- The BMW Scholars are seen as a critical part of the workforce team at BMW, not as an add-on done out of corporate good will, but out of real necessity.
- Being transparent in terms of requirements for success in the programme. Students are put through probation if they can’t maintain their GPA scores.
- This programme leads to employment. “One of the advantages to being here is that this programme is seen as an inside track to employment, you’re visible to mentors. We want their experience here to be positive, to say yes to future employment.
- One of the key aspects is our recruiting work at the high school and middle school levels. Other states and companies could learn from us. BMW visited close to 300 students and their parents last year, both at their schools and bringing them to the plant. Parents and students were astonished to see the technology of the manufacturing plant (BMW officials).
- High school (and technical college) teachers would benefit by visiting the plant, learning about the skills needs, and seeing how students are being trained so they could bring that knowledge back into their classrooms. One possible weakness of this programme is that too few instructors have the opportunity to visit the plant.

⁴⁹ World Economic Forum and PWC,(2011) “The War for Talent Goes Public”, available online at: http://www.pwc.com/en_GX/gx/hr-management-services/pdf/war-for-talent-goes-public.pdf

Analysis section

Purpose

The purpose of this analytical review is to compare how the three high skills, youth apprenticeship programmes in mechatronics relate to their counterparts in Germany, home of the dual system, and through the framework of the ILO's 16 Key Elements of Quality Apprenticeships (see Annex 4 for full document). The next section makes recommendations for what lessons could be learned by other states and communities who are considering similar apprenticeship programmes. A final section identifies challenges and opportunities from the perspectives of senior leaders in the U.S. Department of Education and Labour and National Governors Association.

Why German companies invest to develop their own high skilled workforce?

VW, BMW, and Siemens share a need for skilled workforce in mechatronics⁵⁰ to fill their talent pipeline. Given the growing demand for mechatronics, they are able to offer good jobs to all the young people who successfully complete their apprenticeship programme. Companies are facing significant skills shortages due to the convergence of a number of factors, such as demographics (retiring skilled workers), low interest and/or demand for careers in manufacturing, a cultural bias that favours college education, and a significant skills gap in STEM related occupations. The three companies reviewed for this study do not appear to fear poaching from other companies who do not invest in building their own skilled workforce. Instead they hope that their workplace and training packages are so attractive that the graduate apprentices will stay and join their technical workforce – or go on to pursue four-year degrees while working at their firms, with full tuition reimbursement. All three companies mentioned their reputation as global leaders in their respective sectors and consider their firms very desirable places to work.

How these programmes differ from each other and their counterparts in Germany's dual system?

- **Time allocation:** at Siemens and BMW the allocation of time is similar to the German dual system where students spend three days per week learning in the workplace and two days per week learning in technical schools. VW uses blocks where apprentices are either studying full time in school or training full time on-site.
- **Company partnership with schools vs. industry association with schools:** the firms have individual partnerships with colleges, where the company supplies the schools with the skills they need and collaborates on training and laboratory procedures. The only exception to that is Siemens-Charlotte where all 28 German companies collaborate together. In the case of South Carolina's technical colleges where a number of high skills employers partner with the colleges, BMW and a number of area companies banded together to develop a mechatronics curriculum ten years ago. It appears they are beginning to consider collaboration with each other. A similar opportunity may exist in Chattanooga. In contrast, in Germany the apprentice curriculum used in companies and schools is determined by the industry association working in partnership with the Education Ministries and relevant trade unions in each state to ensure that apprentices leave with a broad base of highly transportable skills.

⁵⁰ National STEM Consortium website: <http://www.nationalstem.org/home/mech/>

- **Student/Apprentice wages:** as in Germany, the apprenticeships are established so that the student incurs no costs for participating in the programme; plus they are paid for their work.
- **Quality of training at work and learning in schools:** as in Germany each of redundant three companies have training facilities, trainers, supervisors, and mentors assigned to the student apprentices. In each firm student apprentices learn by doing. They have to “report back” what they learned to the designated supervisor at each of the stations. It appears that the integration of learning at the firm and the college is most tightly interconnected at Siemens and Piedmont Community College, where the State helps fund college instructors to go to Germany for certification and training.
- **Gender and ethnic balance:** as in Germany, more males appear to want to work in these technical fields. However, each company appears to have made every effort to include women and young people from various ethnic backgrounds.

Brief review of Quality Youth Apprenticeships in VW, BMW and Siemens in the U.S. using ILO’s Key Elements of Quality Apprenticeships

Element 1: Key Participants in the Programme		
Siemens	BMW	VW
<ul style="list-style-type: none"> ➤ High school and community college students, and some Adult programmes ➤ Siemens corporate leaders and trainers ➤ Piedmont Community College ➤ Apprenticeship 2000 Consortium ➤ State of North Carolina 	<ul style="list-style-type: none"> ➤ Technical College students ➤ BMW corporate leaders and trainers ➤ Three area Technical Colleges ➤ State of South Carolina ➤ other major employers in Spartanburg region, (however the connection between employers appears weakly developed to date) 	<ul style="list-style-type: none"> ➤ Technical College students ➤ VW corporate leaders and trainers ➤ Chattanooga State Technical College ➤ Tennessee Technology Center ➤ State of Tennessee

Strengths

1. *Inclusion of high school students:* Although Siemens is the only company that starts with high school students as a part of the programme, the other two firms made it clear that they are reaching into the areas’ high schools and even junior high schools because the development of STEM skills must start early in the education process.
2. *Corporate leadership drives the programme:* In each of the three companies, corporate leaders are deeply involved in the programme and support it fully. The importance of private sector leadership (demand driven programmes) for youth employment has been documented⁵¹ and is essential, as supply driven solutions (led by education alone) often lack the connection to the labour market and its current and future skill needs.
3. *Clear accountability:* In each of these programmes accountability for performance is clearly established for all participants and drives a process of continuous improvement.

⁵¹ Aring, Monika, and Cathleen Corbitt. Compass for Workforce Development. Education Development Center, Inc. For USAID. 1996. Available online at: http://pdf.usaid.gov/pdf_doc/PNACB077.pdf

4. *Open Access:* Any student can participate, providing they have the necessary traits and STEM skills as determined by the companies' screening process. Students in the three companies come from a wide variety of backgrounds and ethnicities.
5. *Other German firms participate in the programme as well.* Firms in Charlotte's Apprenticeship 2000 program (Blum and others), as well as firms in the more recent Apprenticeship Charlotte Program are part of some of the programme activities in the Siemens programme, such as testing, assessments, reaching out to high and junior high schools).

Weaknesses

Failure to collaborate on training on the part of companies in the region: Germany's dual system is a response to an industrial competitiveness strategy, which does not yet exist in the U.S. As a result, in the U.S., even companies within a sector rarely invest together or collaborate with each other on the provision of education and training for skills development.⁵² An industrial competitiveness strategy exists in each the states of Tennessee, North Carolina, and South Carolina, but so far it has not resulted in different companies banding together to solve their skills needs in the three states. While German companies collaborate in the Siemens case, in the case of South Carolina's well-developed Technical Scholars program, area employers such as Michelin, Boeing, and Bosch work on their own with the region's technical colleges. The same appears to be true for Tennessee. Each company's programme is different. While there may be advantages for the companies to go it alone, the costs associated with their individualistic approach include inefficiencies, duplication of effort, likely higher costs for the colleges, and lack of a transparent and coherent system of information on skill needs for the secondary schools that feed the Technical colleges. According to interviews with Technical College officials in South Carolina, Michelin, Boeing and BMW are bringing all their Tier 1 and Tier 2 suppliers within the region. This could provide a real and viable opportunity for companies to start collaborating on skills development.

Element 2: Main Objectives		
Siemens	BMW	VW
<ul style="list-style-type: none"> ➤ Closes skills gaps ➤ Provides young apprentices with high and portable skills and international certifications in mechatronics ➤ Stepping stone to a four-year engineering degree ➤ Designed to help company meet current and future skill needs ➤ Provides a seamless transition from school to work ➤ Supports economic growth, competitiveness and productivity through increased STEM skills 	<ul style="list-style-type: none"> ➤ Closes skills gaps ➤ Provides young apprentices with high and portable skills and international certifications in mechatronics ➤ Stepping stone to a four-year engineering degree ➤ Designed to help company meet current and future skill needs ➤ Provides a seamless transition from school to work ➤ Supports economic growth, competitiveness and productivity through increased STEM skills 	<ul style="list-style-type: none"> ➤ Closes skills gaps ➤ Provides young apprentices with high and portable skills and international certifications in mechatronics ➤ Stepping stone to a four-year engineering degree ➤ Designed to help company meet current and future skill needs ➤ Provides a seamless transition from school to work ➤ Supports economic growth, competitiveness and productivity through increased STEM skills

⁵² There are significant exceptions to this statement, esp. in the case of occupations that are considered critical, such as the professions (medicine, accounting, etc.) where employers collaborate on defining skill needs and certify curricula.

Strengths: all three programmes

1. *Focus on high skills:* mechatronics is a high skill occupation requiring the integration of mechanics, electronics, software, and engineering disciplines.
2. *Close a critical skills gaps and filling future skills pipeline:* All three programme focus on closing a critical skills gap, in this case mechatronics, which represents the competencies required to manage current and future highly automated industrial production processes based on programmable logic control systems.
3. *Provide seamless transfer to four-year engineering degrees:* One of the typical objections in the U.S. to technical or vocational education is that it traps students in low skills occupations, where college is the desired stepping stone into a future that could provide more opportunities. The programmes offered by all three companies make it possible for students to move directly into further studies leading to a four-year engineering degree, paid for by the company.
4. *Provide a seamless transition from school to work:* Because success in mechatronics requires STEM skills, all three companies are reaching into high schools, talking with guidance counsellors, students, and parents, many of whom are initially sceptical or opposed to the idea of manufacturing occupations. Siemens has the most developed approach and directly recruits from high schools, while BMW and VW seem to work through their technical colleges.
5. *Support economic growth as well as manufacturing growth through focus on STEM skills.* STEM skills have been defined as very high priority⁵³ for the U.S.
6. *Support closing of skills gaps, in soft skills, learned by doing, not theory.* A review of over 100 employer reports in 40 countries on skills gaps shows that about 50% of the skills gap is in relation to “soft skills.”⁵⁴ In the U.S., For example, According to ASTD’s poll of 1,179 U.S. organizations about the extent of their skills gaps, more than half the organizations surveyed (51 per cent) said the skills of the current workforce do not match changes in company strategies, goals, markets or business models. 46 per cent of organizations surveyed state “basic skills – the traditional building blocks of business leverage competencies are lacking” (ASTD, p.8). Similarly, a 2011 Manpower Group survey of 40,000 employers in 39 countries reports a dramatic surge in the U.S. in terms of difficulty in filling positions, with the difficulty increasing from 14 to 52 per cent from 2009-2010 (Manpower, p.2). A 2005 Skills Gap report by Deloitte and the National Association of Manufacturers (NAM) shows 81 per cent of respondents are facing “a moderate to severe shortage of qualified workers.” The Deloitte and NAM report concludes “the vast majority of American manufacturers are experiencing a serious shortage of qualified employees, which in turn is causing significant impact to business and the ability of the country as a whole to compete in the global economy” (NAM, p.1).

Weaknesses

These are individual programmes, to be fully sustainable; they need to become systemic and driven by a number of companies, all of whom depend on employees with strong STEM and soft skills. While this is not a weakness of the programmes examined in these three case studies, as long as they exist as individual programmes only, they run the risk of being abandoned or weakened in various ways. Moreover if companies do not band together to invest in this kind of training any one firm’s investment is vulnerable to poaching by other employers. For example, according to a National Association of Manufacturing report, in the U.S., “in terms of skills gaps among production employees, 90 per cent of respondents indicated a moderate to severe shortage of

⁵³ STEM Solutions, Announcement of National Conference. Austin, TX. August 2013. Available online at <http://usnewsstemsolutions.com/press-releases>

⁵⁴ Aring, Monika. Employer Reports of Skills Gaps in the U.S. An analytical study for UNESCO. November, 2012

qualified skilled production workers, and 65 per cent reported a moderate to severe shortage of scientists and engineers. The impact of the science and engineering skills gap appears to be more severe for larger firms, as companies with over 500 employees reported a 74 per cent shortage of scientists and engineers. While employees with technical skills are in especially short supply according to the NAM survey, approximately 40 per cent of responses indicate skill gaps in the area of soft skills, such as customer service and sales and marketing (NAM p. 4). These skills gaps reflect both gaps in knowledge and skills, as well as actual shortages, as many U.S. jobs will require more education and training in the next five years. The U.S. National Center for Education Statistics finds that 12 of the nation's 20 fastest-growing occupations will require an Associate's Degree or higher by 2015 (ASTD p 9).⁵⁵

Element 3: Main Beneficiaries		
Siemens	BMW	VW
<ul style="list-style-type: none"> ➤ Young people who gain high skills ➤ Siemens and possibly other firms for whom apprentices can work ➤ Community College gains significant knowledge and access to state-of-the-art technology and practices 	<ul style="list-style-type: none"> ➤ Young people who gain high skills ➤ BMW and possibly other firms for whom apprentices can work ➤ Technical Colleges gain significant knowledge and access to state-of-the-art technology and practices 	<ul style="list-style-type: none"> ➤ Young people who gain high skills ➤ VW and possibly other firms for whom apprentices can work ➤ Technical College and Tennessee Technical Center gains significant knowledge and access to state-of-the-art technology and practices ➤ TN technical colleges learn about missing skills, especially soft skills such as work ethics

Strengths

As in win-win-win-partnerships, each stakeholder benefits from their respective programmes.

a. Young people benefit by

- i. Gaining transportable skills that are well paid and in high demand at no cost to themselves (except their time).
- ii. Obtaining internationally recognized certifications in mechatronics that establish their value in the marketplace.
- iii. Better, more integrated learning - seeing how the content they are learning in school is used at the workplace.
- iv. Ability to pursue a four-year engineering degree at no cost to themselves (except time).

b. The three firms benefit by

- i. filling a pipeline of skill needs that will help them compete globally and from their U.S. plants.
- ii. "capturing" the loyalty of the young trainees so that they will go to work for them upon the conclusion of the programme.

⁵⁵ ASTD. 2009. Bridging the Skills Gap: New factors compound the growing skills shortage. ASTD. Alexandria, VA. Available online at: <http://store.astd.org/Default.aspx?tabid=167&ProductId=21008>

c. The Community or Technical Colleges benefit by

- i. Gaining access to state-of-the-art information and resources on mechatronics occupations and their skill requirements, making their programmes for other employers more attractive and being able to interest more and better students.
- ii. Especially in the Siemens case, Piedmont Community College benefits by having its teachers exposed to practices in the plant so that their teaching reflects state-of-the-art practice, tools, and techniques.

d. Area high schools benefit by

- i. Learning about the practical value of STEM skills.
- ii. Exposure of students, faculty, and counsellors to real demands for skills in state-of-the-art production.
- iii. Teachers' exposure to mechatronics and state-of-the-art production facilities (esp. in the case of Siemens).

e. The states benefit by

- i. The companies' investments in developing STEM skills, which are the cornerstone of knowledge economies and which make their states more competitive.
- ii. The financial and other forms of investment on the part of the three firms in training and skills development of the workforce.
- iii. Sharing between the firms and local training institutions of their best practices, knowledge, and in some cases, training curriculum.
- iv. Having internationally certified workers makes their labour pool more attractive for other firms and it also builds the skills base in the state.
- v. Potentially leveraging the companies' leadership in training investments so that other firms invest as well.
- vi. More highly skilled workers can spend more, resulting in multiplier effects in the state's economy.
- vii. More tax revenues coming from higher skills; therefore higher paid workers.

Weaknesses

All of the weaknesses result from the highly individualistic approach found in the U.S., a failure of collective action for the common good. For example,

1. *Failure to leverage investments across employers.* The states involved, while entrepreneurial, do not appear to leverage the investment of each of the three firms to produce a larger collective of companies who share the investment in training. They also do not appear to recognize that this kind of investment by the German firms is a competitiveness strategy that they should leverage throughout the state and its firms. This failure is likely to result in poaching, where other companies do nothing and hire away those workers trained by investing firms by offering the graduates more money.
2. *Failure to leverage new knowledge investments across school districts.* In the U.S., school districts operate as highly independent units and what is learned in one does not often easily translate to other districts. It is unclear to what extent the knowledge acquired by the Charlotte Mecklenburg district about teaching and learning STEM skills is being leveraged across other school districts and other U.S. states.
3. *Failure to leverage investments by the firms for State and Federal Apprenticeship policy tools.* For example, a number of policy tools could be developed by the States to make it easier for firms to invest in the kinds of training that the three German firms are demonstrating as possible. However, there are to date few if any policy instruments at the state or federal levels that could provide incentives, share best practice, or encourage more collective action, or inspire a national industrial policy.

Element 4: Rights of Participants		
Siemens	BMW	VW
<ul style="list-style-type: none"> ✚ No legal framework for youth apprentices in the State or USA ✚ Provides occupational health and safety protection ✚ Provides equal access to the programme ✚ Encourages participation of women 	<ul style="list-style-type: none"> ✚ No legal framework for youth apprentices in the State or USA ✚ Provides occupational health and safety protection ✚ Provides equal access to the programme ✚ Encourages participation of women 	<ul style="list-style-type: none"> ✚ No legal framework for youth apprentices in the State or USA ✚ Provides occupational health and safety protection ✚ Provides equal access to the programme ✚ Encourages participation of women

Strengths

1. *Provides equal access to the programme.* In BMW and Siemens,⁵⁶ students clearly come from a variety of backgrounds and ethnic groups.
2. *Strong insistence on occupational health and safety measures.* Occupational Health and Safety (OSHA) is a cornerstone of US manufacturing practice and all three firms comply or exceed in compliance with OSHA regulations.
3. *Encourage the participation of women.* In BMW and Siemens women participate in the apprenticeship mechatronics programme; however, in fewer numbers.
4. *Contract between each firm and student apprentices.*

Weaknesses

1. *There is no legal framework protecting the rights of young apprentices.* Even though the firms appear to be vigilant in protecting the rights of student apprentices, the lack of a legal framework makes enforcement of any potential transgressions problematic.
2. *Student apprentices would appear to have no legal recourse if there are problems.*
3. *There is no legislation at the level of the States or federal government protecting student apprentices.*

Element 5: Income and Support for Apprentices		
Siemens	BMW	VW
<ul style="list-style-type: none"> ✚ Contractual relationship between apprentice and Siemens, between Siemens and CPCC ✚ Apprenticeship wages comply with state and federal minimum wage requirements and include periodic salary increases 	<ul style="list-style-type: none"> ✚ Contractual relationship between apprentice and BMW, between BMW and Technical Colleges ✚ Apprenticeship wages comply with state and federal minimum wage requirements and include periodic salary increases 	<ul style="list-style-type: none"> ✚ Contractual relationship between apprentice and VW, between VW and CSTC ✚ Apprenticeship wages comply with state and federal minimum wage requirements and include periodic salary increases

⁵⁶ Unable to interview VW student apprentices.

Strengths

1. *Contract specifying terms of agreement between the student apprentice and the company.* According to interviews, the contract specifically states the length of the apprenticeship, wages and wage increases, conditions of satisfaction, and other factors.⁵⁷
2. *Apprenticeship wages comply with state and federal minimum wage requirements and include periodic salary increases.*
3. *Wages cover the needs of student apprentices so that they leave the programme with zero debt to their college and in some cases, are able to help their families.* In general, each firm makes sure that the salary paid to student apprentices is sufficient to cover their needs in terms of sustaining themselves so that they leave the programme with zero debt. Wages paid are higher than those found in local service jobs, according to students interviewed.

Weaknesses

None perceived.

Element 6: Apprenticeship Funding		
Siemens	BMW	VW
<p>↘ Assumed largely by Siemens with financial support from State of NC and Community College system</p>	<p>↘ Assumed largely by BMW with financial support from Technical College system and State of SNC</p>	<p>↘ Assumed largely by VW with support from Chattanooga State and TN Technology Center and State of TN</p>

Strengths

1. *Financial commitment and size investment.* The programmes' major strength, the commitment and investments on the part of the three companies (approximately \$160,000 per student), ensuring that no student incurs costs (other than transportation) for the duration of their apprenticeship, certifications, and two-year Associate's Degree.
2. *"Guaranteed" job offer at the end of the programme* without requiring that the student commits him or herself ahead of time to work for the company.
3. *Investments and commitments on the part of each of the states, and their community and technical college systems.* This type of multi-stakeholder investment where each party wins lies at the heart of Germany's dual system and makes it sustainable over time.

Weaknesses

1. *Financial commitment and size of investment.* It is very likely that U.S. employers would not consider investing \$160,000 per student apprentice. Companies in Germany finance the dual system largely via a voluntary payroll tax they charge themselves. They make the significant investment (usually between \$50,000-\$150,000 per year per student apprentice) because in the long run it saves them money in that they 1) have access to a pre-qualified pool of future workers whom they can train once they've decided to hire them after the dual system apprenticeship has completed; and 2) they can contain their labour costs for highly skilled workforce by having a large pool of highly skilled new entrants.

⁵⁷ Unable to review contracts.

2. *Lack of sustainability over time.* Most U.S. employers consider training investments in their future workforce as a cost to be managed, as opposed to an asset to be developed. This fundamental difference in perspective may make it quite challenging to obtain the participation of other firms so that this approach could become sustainable.
3. *Lack of resources on the parts of the colleges.* In the case of North Carolina and Tennessee, the technical and community college leaders have to behave very entrepreneurially to ensure funding for their part of the investment in the programmes. This dependence on the entrepreneurial nature of college staff and leaders, while having many positive benefits, also weakens the programme. For example, the leadership changes and the entrepreneurial attitude goes away.
4. *Lack of sustainable funding mechanisms on the part of the states involved.* Interviews with State officials indicate that these officials have to behave entrepreneurially as well to find financial resources to support the programme. While this is undoubtedly a positive quality among public sector officials, these kinds of investments are not yet sufficiently institutionalized to make them sustainable over time and through different political administrations.

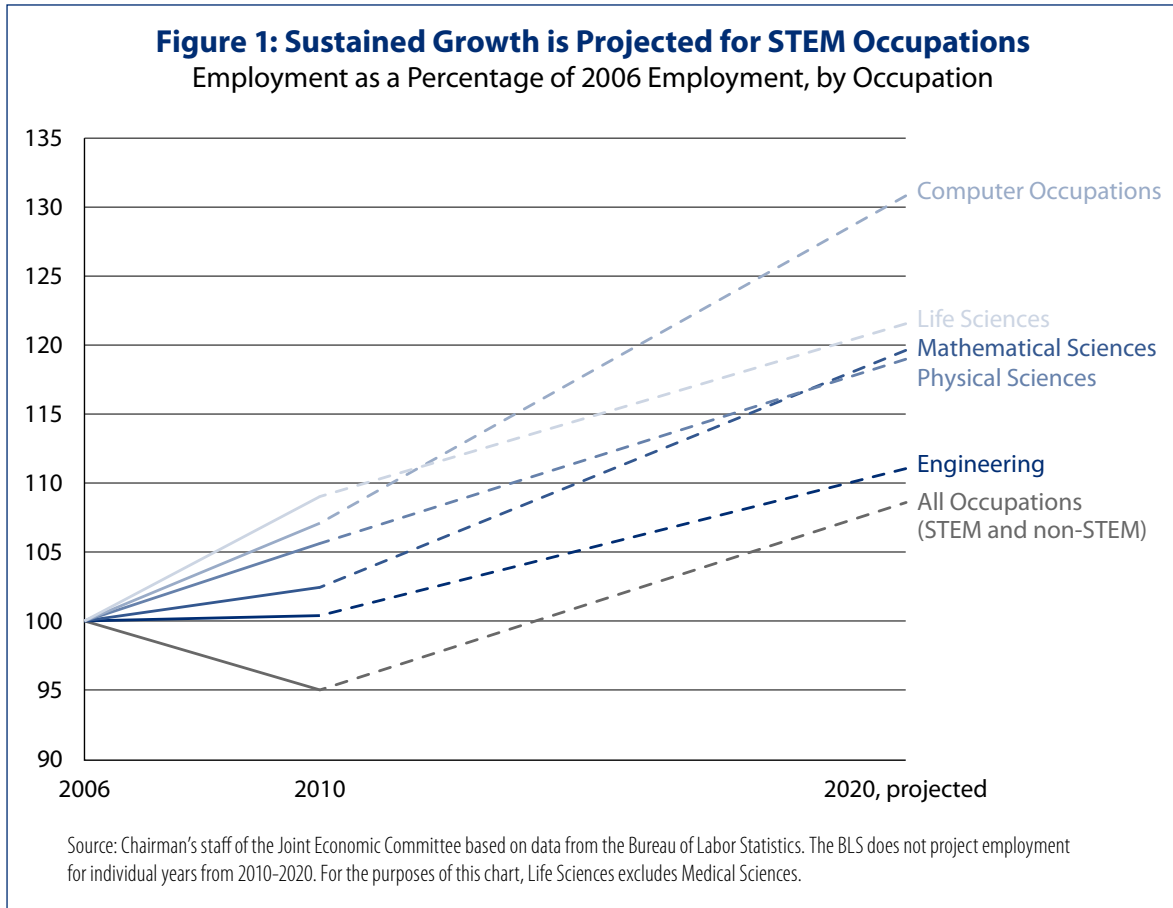
Element 7: Eligible Occupations for Apprenticeship Programmes		
Siemens	BMW	VW
<p>↘ Focused on skills gap in labour market: mechatronics technicians</p>	<p>↘ Focused on skills gap in labour market: mechatronics technicians</p>	<p>↘ Focused on skills gap in labour market: mechatronics technicians</p>

Strengths

1. *Strong demand forecast for mechatronics technicians.* The U.S. Department of Labor has referenced mechatronics as a new and emerging growth area that also has been identified as one of the in-demand industry clusters. The Bureau of Labor Statistics does not collect employment data or wage data on mechatronics technicians; however industry sources suggest that the annual wage is about \$50,000, and the job outlook is bright through 2018. The National Council on Competitiveness estimates that 100 million new jobs will be created in the 21st century at the intersection of disciplines rather than in individual disciplines. Mechatronics technicians exhibit this multi-disciplinary or multi-skilled requirement.⁵⁸
2. *Strong demand for STEM skills:* According to a 2012 U.S. Congressional Report, despite the clear demand for STEM talent by domestic employers, the U.S. is failing to produce an ample supply of workers to meet the growing needs of both STEM and non-STEM employers. The existing STEM pipeline leaves too many students without access to quality STEM education, and without the interest and ability to obtain a degree or work in STEM.⁵⁹

⁵⁸ National STEM Consortium website 2012

⁵⁹ STEM Education. Preparing for the Jobs of the Future. Available online at: http://www.jec.senate.gov/public/index.cfm?a=Files.Serve&File_id=6aaa7e1f-9586-47be-82e7-326f47658320



Weaknesses

None perceived

Element 8: Appropriate education levels to incorporate youth into apprenticeship programmes		
Siemens	BMW	VW
<ul style="list-style-type: none"> ➤ Programme tests for aptitude and education achievement and teaches STEM skills ➤ Siemens leaders reach into high and junior high school faculty and parents on need for STEM skills 	<ul style="list-style-type: none"> ➤ Programme tests for aptitude and education achievement and teaches STEM skills ➤ BMW leaders reach into high and junior high school faculty and parents on need for STEM skills 	<ul style="list-style-type: none"> ➤ Programme tests for aptitude and education achievement and teaches STEM skills ➤ VW leaders reach into high and junior high school faculty and parents on need for STEM skills

Strengths

1. *Quality of high school.* Leaders in the Siemens case appear to have a high opinion of their feeder high school.
2. *Willingness on the part of the companies to educate teachers about mechatronics and STEM skills.* The companies have to help teachers understand how mechatronics uses STEM skills.
3. *Willingness on the part of the companies to teach parents, guidance counsellors and students in junior and high school about mechatronics and the state-of-the-art in advanced manufacturing.*

Weaknesses

1. *Weaknesses in the K-12⁶⁰ math and science education.* So far corporate leaders in each of the states have been able to find sufficient candidates to test and select. However, leaders in each of the three companies are careful to state that to ensure future supply of student apprentices they have to reach deeply into the high schools and even junior high schools to make students, faculty, and parents aware of the need for STEM skills and their importance in obtaining well-paying, good entry level jobs in manufacturing. According to a 2012 report by the Joint Economic Committee of the U.S. Congress, American students' performance on international standardized tests suggests serious problems earlier in the STEM pipeline. For example, U.S. 15-year-olds rank 25th in math and 17th in science in PISA scores among the 34 OECD nations. As discussed below, other international comparisons as well as performance on domestic examinations suggest that problems in U.S. STEM education may begin as early as elementary school and continue through students' secondary and post-secondary education."
2. *Weak performance in U.S. on STEM skills.*⁶¹ According to the same Congressional report, the United States is falling behind in international comparisons when it comes to providing an adequate supply of STEM workers, ranking 23rd among 34 OECD member countries. The report states, "while we should be cautious in making international comparisons of countries which have dramatically varying sizes, diversity of populations, and industrial policies, the U.S. continues to fall behind key international competitors across a wide set of different measures of STEM preparedness".⁶²
3. *In the U.S. manufacturing tends to be misunderstood and often considered "dirty" and undesirable by students, teachers, guidance counsellors and parents.* Corporate and college leaders repeatedly stressed the importance of changing the minds and hearts of parents, students, and teachers when it comes to manufacturing occupations. Considered dirty and low paying, parents, students and teachers do not understand modern (advanced) manufacturing, and have images from an industrial past, often in their states, where manufacturing was dirty and dangerous and required few skills.

Element 9: Key issues to ensure labour market relevance		
Siemens	BMW	VW
<p>✚ Qualifications and skills provided match evolving labour market demands as anticipated by Siemens global operations</p>	<p>✚ Qualifications and skills provided match evolving labour market demands as anticipated by BMW global operations</p>	<p>✚ Qualifications and skills provided match evolving labour market demands as anticipated by VW global operations</p>

⁶⁰ K-12 refers to US education from Kindergarten through 12th grade, the end of compulsory education

⁶¹ STEM Education: Preparing for the Jobs of the Future. U.S. Congress Joint Economic Committee: A Report by the Joint Economic Committee Chairman's Staff Senator Bob Casey, Chairman. April 2012. Available online at: http://www.jec.senate.gov/public/index.cfm?a=Files.Serve&File_id=6aaa7e1f-9586-47be-82e7-326f47658320

⁶² The Joint Congressional Committee states: "While the U.S. produces by far the greatest number of STEM degree recipients among OECD countries (348,484 in 2008), adjusting for the overall number of degrees and for the population paints a different picture. By one measure – the share of students receiving degrees in STEM fields – the U.S. compares unfavorably with other global competitors. For example, NAFTA members Canada and Mexico, and many European nations including economic powerhouse Germany, graduate more STEM students as a share of all degrees than the United States does.³⁰ This is also true when looking at STEM graduates as a share of the employed 25-34 year old population, where the U.S. ranks 23rd among OECD countries."

Element 9: Key issues to ensure labour market relevance		
Siemens	BMW	VW
<ul style="list-style-type: none"> ➤ The International Certification for Mechatronics facilitates occupational mobility of apprentices ➤ Students are continuously trained throughout the apprenticeship period ➤ Through their participation with the 20 other German firms, Siemens fosters close collaboration, consultation, alliance and dialogue among relevant stakeholders, especially training institutions, employers, business stakeholders and professional associations ➤ The training manager and staff and plant leadership continuously review relevance of apprenticeship learning ➤ Siemens is reaching down into the K-12 system to provide pathways for entry, as well as assurance of high quality trainers and training provision of on-the-job and off-the-job mentoring 	<ul style="list-style-type: none"> ➤ The International Certification for Mechatronics facilitates occupational mobility of apprentices. Apprentices can go to work anywhere in the world upon completion of programme ➤ Students are continuously trained throughout the apprenticeship period ➤ BMW works with the 3 Technical Colleges but so far has not worked closely with other firms ➤ The training manager and staff and plant leadership continuously review relevance of apprenticeship learning ➤ BMW is reaching down into the K-12 system to provide pathways for entry, as well as assurance of high quality trainers and training provision of on-the-job and off-the-job mentoring 	<ul style="list-style-type: none"> ➤ The International Certification for Mechatronics facilitates occupational mobility of apprentices. Apprentices can go to work anywhere in the world upon completion of programme ➤ Students are continuously trained throughout the apprenticeship period ➤ VW works with the Tennessee Technical College but so far has not worked closely with other firms ➤ The training manager and staff and plant leadership continuously review relevance of apprenticeship learning ➤ VW is reaching down into the K-12 system to provide pathways for entry, as well as assurance of high quality trainers and training provision of on-the-job and off-the-job mentoring

Strengths

As described in the table above, all three programmes ensure labour market relevance. Each of the firms involved:

1. is a recognized industry leader and linked into various industry and professional organizations.
2. provides graduates with internationally recognized certificates that they can use anywhere in the world. For example, trainers in all three companies emphasized that graduate apprentices can work in any of their plants anywhere in the world. Given the firms leadership position, the certification in mechatronics will be recognized by other leading firms.
3. The firms' participation with local Technical or Community Colleges provides important feedback loops from the firm to the colleges and from the colleges to the German and other area firms, even though these are not involved in the programme. These feedback loops help assure that student apprentices are indeed learning transportable skills that are in demand.

Weaknesses

The primary weakness is the fact that in the U.S. context where firms tend to not share practices and where industry associations do not focus on collective action when it comes to training needs, it falls upon the education system to make sure that students' skills are indeed transportable, transferable to other firms and viable in the today's and tomorrow's labour market. In Germany and northern Europe, industry associations in each sector identify current and anticipate future skill needs, working collaboratively with the various ministries of education in each state. This has not yet happened in the various U.S. states nor at the federal level. It places a real constraint on the ability of the community colleges and firms to ensure they are training to current and future skill needs.

Element 10: A good career guidance-apprenticeship relationship		
Siemens	BMW	VW
<p>➤ According to interviews with plant officials, knowledge, information, and understanding about mechatronics and high skills apprenticeship needs to be built at the high school and junior high school levels. High school counsellors focus on helping students go to college.</p>	<p>➤ According to interviews with plant officials, knowledge, information, and understanding about mechatronics and high skills apprenticeship needs to be built at the high school and junior high school levels. High school counsellors focus on helping students go to college.</p>	<p>➤ According to interviews with plant officials, knowledge, information, and understanding about mechatronics and high skills apprenticeship needs to be built at the high school and junior high school levels. High school counsellors focus on helping students go to college.</p>

Strengths

None perceived.

Weaknesses

Exclusive focus on sending students to college. Career guidance in most U.S. high schools tends to focus exclusively on helping students get into college, as the entire system tends to be oriented for post-secondary education.

No state-wide or national youth apprenticeship system. Despite a nationwide effort during the Clinton administration to develop a youth apprenticeship system in the U.S., these efforts were aborted during the subsequent administration. There is no youth apprenticeship system in the U.S. and it is likely that few, if any, career counsellors are aware of youth apprenticeship as a promising option for students.

Element 11: Improving skills through apprenticeships		
Siemens	BMW	VW
<p>➤ Mechatronics technical and soft skills integrated through practice and learned in theory at school and workplace</p>	<p>➤ Mechatronics technical and soft skills integrated through practice and learned in theory at school and workplace</p>	<p>➤ Mechatronics technical and soft skills integrated through practice and learned in theory at school and workplace</p>

Strengths

1. *Integration of theory and practice.* Integrating theory with practice is widely recognized as critical to learning and retention.⁶³ Facility in mechatronics requires the integration of engineering, software, electronics, and mechanics. Students in the apprenticeship programmes say that it is extremely helpful for them to see a topic covered in their college class and then see how it is applied and used at the firm.
2. *Improving skills of teachers in community and technical colleges.* Virtually all the community or technical college teachers in the three programmes and states either come from the industry sector or have a strong background in industry. However, as in other fields, mechatronics is evolving as a discipline and it is important that teachers can keep pace with their knowledge, skills, and ability to apply knowledge to specific problem sets. The Siemens programme appears to do the most to help community college teachers learn by sending them for training to Germany and helping them obtain certifications on particular applications.

Weaknesses

1. *Upgrading teachers' skills and knowledge.* The Technical College programme appears to have the weakest connection in terms of upgrading college teachers' skills and knowledge so it remains current. Several teacher interviews indicate that while they come from the industry, only a few of them go back to upgrade their skills or even visit to see how students are learning at the firms.
2. *Lack of leverage of knowledge to other programmes in the Community and Technical Colleges.* These apprenticeship programmes are generating valuable knowledge, not only about how to teach mechatronics at work and in school, but also about how to teach the integration of many disciplines in a highly efficient manner. Why are these programmes not being studied by learning researchers? And to what extent is the knowledge generated by these programmes spilling over to other programmes in the Community and Technical Colleges system?

Element 12: An active role of business and labour organisations		
Siemens	BMW	VW
<p>↘ Some 200 German companies in Charlotte have formed Apprenticeship 2000 to deal with skills gaps. The Siemens programme is a part of the larger programme. Labour organisations are not involved, as degree of unionization in NC is lowest in the nation, at 2.9%</p>	<p>↘ A number of major multinational companies operate in the Spartanburg-Greenville area. A number have a cooperative programme with the area's Technical College. The BMW programme has the deepest corporate engagement with the Technical Colleges in the area. Labour organisations are not involved, unionization in SC is second lowest in the nation, at 3.4%</p>	<p>↘ VW has launched a number of partnership programmes with educational institutions at all levels – K-12 to post-graduate. Labour organisations are not involved. Tennessee's unionization rate is 4.8%</p>

⁶³ Stipek, Deborah J. Motivation to Learn: Integrating Theory and Practice, 4/E. Stanford University. Pearson 2001.

Strengths

1. *Collective action to train high skills student apprentices.* In 2000, seven German firms in the Charlotte area banded together to form Apprenticeship 2000⁶⁴ in order to “grow their own” future workforce in high skills occupations. More recently a number of additional German firms have created another association, called Apprenticeship Charlotte.⁶⁵
2. *Collective action to develop a mechatronics curriculum.* Approximately ten years ago a number of companies who were working with South Carolina’s Technical Colleges joined forces under the lead of BMW to develop a mechatronics curriculum.

Weaknesses

1. *Programmes limited to German firms.* While it must be emphasized that these programmes are only two to three years old, it is interesting to note that other firms have not joined in. Even despite the fact that the community or the technical colleges involved in the programme could serve as organizing forces that would bring many area companies together to initiate a conversation about joining forces.
2. *Lack of long-term mechanisms to ensure that the rights of young apprentices are being ensured.* In the German dual system, labour unions participate in the youth apprenticeship programme. Their role is to ensure that the training young people receive at companies is as broad as possible – instead of focused on the more narrow needs of a particular job. Broad training helps assure transportability, as there is no guarantee in the dual system that any employer will hire a young apprentice upon graduation. The states of Tennessee, North and South Carolina are right to work states (MKA CHECK TN). Since less than 5 per cent of the workforce is organized, it is unlikely that labour unions will play any role in a near future in the apprenticeship programmes reviewed here.

Element 13: Apprenticeships and the informal, unorganized sector		
Siemens	BMW	VW
N/A	N/A	N/A

Note:

This element applies to developing countries, where a significant part of business is found in the informal or unorganized sector. The three programmes are a part of the formal, organized sectors of the economies of the three states.

⁶⁴ Inside the Apprenticeship 2000, each partner company is responsible for their own training investments. Blum invests on average \$160,000 into each student. Apprenticeship 2000 Program Overview, available online at <http://apprenticeship2000.com/partners/Apprenticeship%20brochure%2010.08.pdf>

⁶⁵ Apprenticeship Charlotte is CPCC's effort to connect talented students to local employers. By combining classroom and workplace learning, both the employers and selected students share a valuable experience that produces immediate results. Program overview available online at <http://www.cpcc.edu/apprenticeships>

Element 14: Encouraging entrepreneurship through apprenticeships		
Siemens	BMW	VW
<ul style="list-style-type: none"> ➤ Entrepreneurship training is not a goal of this programme, although graduates would be qualified to work independently as contractors ➤ Recognition and validation happens through certification of skills via Siemens tools as well as via IHK Karlsruhe, ➤ all certifications internationally recognized 	<ul style="list-style-type: none"> ➤ Entrepreneurship training is not a goal of this programme, although graduates would be qualified to work independently as contractors ➤ *Recognition and validation happens through certification of skills via BMW. All certifications internationally recognized 	<ul style="list-style-type: none"> ➤ Entrepreneurship training is not a goal of this programme, although graduates would be qualified to work independently as contractors ➤ *Recognition and validation happens through certification of skills via BMW. All certifications internationally recognized

Strengths

Graduates can work as independent contractors for their current (and other) firms, and this may be a desirable option. During interviews with programme leaders at community and technical colleges several faculty pointed out that graduates may prefer to work as independent contractors, as they may have more control over their hours and receive significantly higher wages, especially for overtime and/or weekend work.

Weaknesses

None perceived.

Element 15: Promoting domestic follow-up of apprenticeship programmes		
Siemens	BMW	VW
<ul style="list-style-type: none"> ➤ Recognition and validation happens through certification of mechatronics skills via Siemens certifications, internationally recognized ➤ Programme is relatively new, insufficient data for large analyses ➤ US does not have a national context in terms of an industrial strategy 	<ul style="list-style-type: none"> ➤ Recognition and validation happens through certification of mechatronics skills via BMW certifications, internationally recognized ➤ Programme is relatively new and there is not yet sufficient data for large analyses ➤ US does not have a national context in terms of an industrial strategy 	<ul style="list-style-type: none"> ➤ Recognition and validation happens through certification of mechatronics skills via VW certifications internationally recognized ➤ Programme is relatively new and there is not yet sufficient data for large analyses ➤ US does not have a national context in terms of an industrial strategy

Strengths

1. *Informal domestic follow-up on the parts of other states and cities.* According to the German Embassy in Washington, DC, so far governors of some nine states and mayors of two cities have expressed interest in duplicating the programme.

2. *Leaders at the U.S. Department of Labor* are pursuing developing youth apprenticeship policy guidelines and strategy.

Weaknesses

No formal domestic follow-up on the parts of other states and cities. Although leaders at the U.S. Departments of Labor and Education expressed great interest in the programmes, officials of the German Embassy have only recently met with leaders at the U.S. Department of Education.

Element 16: Other key elements

Strengths

1. *Numerous requests for information from other States, agencies, and foundations.* Siemens' programme is continually responding to requests for information from other States, agencies and foundations.
2. *The apprenticeship programme can be used as a stepping-stone toward a four-year degree in engineering.* The apprenticeship programme and two-year Associate's Degree can be used as credit toward a four-year engineering degree (financed by each of the companies).

Weaknesses

1. *Programme does not yet extend to suppliers to the three companies.* Given the newness of these programmes it is not surprising that they do not yet include suppliers. In that sense it is not fair to consider this a weakness.

Lessons Learned

Seven states, North and South Carolina, Virginia, Maryland, Pennsylvania, Massachusetts, Wisconsin, and Ohio, as well as the City of Chicago, are exploring the possibility of developing similar (youth) apprenticeship programmes. The three cases where German firms are importing their training approach to the U.S. context are strikingly similar in the fact that they exhibit a similar set of success factors, such as:

- The German firms view the (young) apprentices as assets to be developed, not costs to be minimized; Siemens and BMW spend upwards of \$160,000 for their young apprentices (data for VW was not available)
- Carefully designed learning experiences that will maximize the acquisition of high skills by combining theory with practical application
- Highly dedicated trainers and management teams
- A strong focus on meeting the needs of their customers (customer mind-set) on the part of all the partners (firm, colleges, state officials)
- Strong partnerships with all parties involved that lead to better accountability, investments, and responsibilities
- Highly entrepreneurial state officials and community college officials
- Allocation of resources to fund the emerging needs of these kind of partnerships
- A strong history of investing in training (a “build your own skills” culture among German firms)
- Resourceful leverage of state resources such as tuition scholarships, subsidies for apprentices, State Technology Centers, State Technical College Networks
- Geographical clusters of similar companies. One of the strongest supporting factors in favour of Siemens is the presence of almost 200 other German companies in its geographical area. This made it possible for Siemens to build upon an already existing German youth Apprenticeship programme started in 2000 by Blum with six other companies. (Apprenticeship 2000). Likewise, in South Carolina’s Spartanburg-Greenville area there is a dense network of companies who utilize the State’s Technical College System for training, though none as comprehensive as BMW, according to interviews.

Recommendations

As manufacturing returns to the U.S., a number of states are interested in bringing similar programmes to their respective states. Detailed recommendations for action go beyond the mandate of this analysis. But, based on the information gathered during the interviews with the companies, partner colleges, apprentices and policymakers it seems that the following should be considered:

- *Support the companies with further financial resources and enhance the partnerships with STEM building efforts* so they can more effectively reach down into the student pipeline in high and middle schools, where STEM skills need to quickly develop.
- *Provide information and technical support* based on an industrial strategy
- *Work with the National Governors Association* or other groups to help interested companies and colleges quickly build similar partnerships
- *Conduct more cost-benefit studies* that show that these programmes' provide a return on investment for the medium and long term for companies who need to innovate and compete globally based on high-skill and high wage approaches.
- *Expand the pool to include other firms in the industry and regions.* According to interviews with Technical College officials in South Carolina, Michelin, Boeing and BMW are bringing all their Tier 1 and Tier 2 suppliers within the region. This could provide a real and viable opportunity for companies to start collaborating on skills development.

Annex 1: Additional data available for BMW

Number of apprentices per 1,000 employed persons in the three German plants/by gender: *70 in any given year = 1 per cent of 7,000.*

Apprenticeship wage as share of skilled workers' wage by sex: *.69 per cent (\$10.75/15.50/hour (gender neutral).*

Duration of apprenticeship/ by sex: *two years (nine semesters including summers) (gender neutral).*

Share of graduates that are in employment one to two years after completion of apprenticeships/ by sex: *100 per cent (gender neutral).*

Annex 2: Detailed Comparison of the 3 Programs

	BMW, South Carolina	Siemens, North Carolina	VW, Tennessee
Number of Apprentices/ Students	35/year for 2 years	15/year for 3 years	24/year for 3 years (will have 108 by 2014)
Education upon entrance	Technical Colleges, some early admissions	Summer before senior year in high school	Technical/Community College
Skills learned	3 tracks: 1) Automotive Technology 2) Equipment Services Associate 3) Production	Training in the mechanics, electronics, software, computers, robotics used in automation systems driven by PLCs.	Automation Mechatronics Programme and Car Mechatronics Programme
Hours in Training	10 hours/week	24 hours/week	In alternating blocks of several weeks
Wages and Benefits	\$10-12.75/hour for training 10 hrs/week at BMW and BMW reimburses tuition at local Technical Colleges, equipment, books, and online courses. 4-year engineering tuition reimbursed if work for BMW	\$9-14.75/hour. All are paid for 40 hours per week even though they train in the factory for only 24 hours per week. Siemens reimburses tuition at the Community college, plus equipment, books. 4-year engineering tuition reimbursed if work for Siemens	N/A Reimburses students for tuition costs, equipment, and books. 4-year engineering tuition reimbursed if work for VW
Student College Attendance	At Technical Colleges for approximately 20 hours/week for two years	At community college for approximately 16 hours/week for three years	At Chattanooga State and Tennessee Technology Center
Degrees and Certifications	Associate's Degree, internationally recognized BMW Certifications	Associate's Degree, Mechatronics certification, internationally recognized	Associate's Degree, AMP and CMP, internationally recognized
Net cost to students	Transportation only	Transportation only	N/A

Annex 3: Comparative data on the three case studies

Quality Apprenticeship	VW	Siemens	BMW
Percentage of apprentices with total of employees/	N/A	10%	0.7%
Number of female apprentices/1000 employed	N/A	7.5% (2 out of 15 are women)	0.3%
Apprenticeship wage as shared of skilled worker's wage	N/A	\$14.40 (gender neutral) \$9/hour during initial summer internship (while still in high school)	\$10.75-15.50/hour (gender neutral)
Duration of apprenticeship	N/A	3 years	2 years (9 semesters including summers)
Share of graduates in employment 1 to 2 years after graduating	N/A	100%	100%
Incentives for all parties/ Policy tools	Yes: TTC, Scholarships	Yes	Yes
Partnerships and culture of collaboration	Yes	Yes	Yes
Clear Accountabilities for all 3 parties (students, firm, college)	Yes	Yes	Yes
Shared investments by firms, schools and governments	Yes	Yes	Yes
Internationally recognized Certifications and Degrees	Yes	Yes	Yes
Close coordination between schools and firms regarding learning	Close coordination using block programme	Very	Low
Portability of courses to four-year degrees	Yes	Yes	Low
College instructors have access to the firm	Yes	Yes	Low

Strong Leadership in firm and college	Yes	Yes	Yes
Use of State financial incentives	Yes	Yes	Yes
Quality of training/ quality of trainers	High	High	High
Leads to viable family-wage careers	Yes	Yes	Yes
Gender equality	Yes	Yes	Yes
Transparent and equitable requirements for entry	Yes	Yes	Yes
Outreach into middle and high schools seen as critical	Yes	Yes	Yes
Pressing Need for skills (high level of retirement in the coming years)	Yes	Yes	Yes
Presence of geographic cluster of similar firms	No	Yes	Yes

Annex 4: Key Elements of Quality Apprenticeships

G20 Labour and Employment Ministers agreed in their meeting in Guadalajara to “Promote, and when necessary, strengthen quality apprenticeship systems that ensure high level of instruction and adequate remuneration and avoid taking advantage of lower salaries.” Quality apprenticeships have been considered by the G20 Task Force on Employment as one of the key policy tools to promote effective school-to-work transitions”.

Apprenticeships are a combination of on-the-job training and school-based education. In the G20 countries, there is not a single, standardized model of apprenticeships, but multiple and varied approaches to offer young people a combination of training and work experience.

In general, apprenticeship programmes may be understood as forms of vocational education and training that combine and alternate periods of theoretical classroom learning and practical training at a workplace. Training periods may be carried out on-the job or at school, depending on the design of the programme and the needs of companies. In some cases, school learning is given greater emphasis, in others, work experience, but all seek a suitable combination of both. Ideally, apprenticeships lead to a formal qualification recognised in the labour market.

Given the differences in apprenticeships and taking into consideration the diversity of national contexts in the G20 countries, the following characteristics are key elements that apprenticeship programmes may include in their design and implementation.

1. Key participants in apprenticeships

- a. Young people mostly, though other age groups may be included.
- b. Employers.
- c. Trade unions.
- d. Training and education institutions and vocational schools.
- e. National, regional and local governments.

2. Main objectives of apprenticeship programmes

- a. Provide workers with knowledge, skills and qualifications needed in a changing work environment.
- b. Avoid skill shortages, tackle skills mismatch and foster lifelong learning.
- c. Help employers raise the level of the workforce skills according to the particular needs of companies.
- d. Provide young people with qualifications facilitating their access to labour market and increasing labour market mobility.
- e. Reduce the incidence and duration of unemployment.
- f. Promote faster and more efficient school-to-work transitions.
- g. Help countries raise school enrolment rate and avoid school drop-outs.
- h. Support economic growth, competitiveness and productivity.
- i. Apprenticeships may be a stepping stone on pathways to satisfying rewarding careers.

3. Main beneficiaries

- a. Apprentices, young people that become skilled workers.
- b. Unemployed individuals who wish to acquire skills to reintegrate the labour market.
- c. Employers that find qualified workforce and loyal workers.
- d. The society as a whole through a better educated workforce, improved human capital, better skills, more employment.

4. Rights of participants

- a. Determine an adequate legal framework to regulate apprenticeships.
- b. Respect the ILO fundamental principles and rights at work.
- c. Facilitate social security schemes for apprentices.
- d. Provide occupational safety and health training and protection.
- e. Ensure equal access to apprenticeship programmes.
- f. Encourage the participation of women and disadvantaged youth and people with disabilities.

5. Income/support for apprentices

- a. Engage in a contractual relationship between the firm and the apprentice that ensures decent working conditions.
- b. Establish minimum wages/adequate remuneration levels for apprentices and ensure that apprentices receive the minimum legal level of remuneration.
- c. Remuneration may reflect low productivity of apprentices while in learning. However, it is fundamental to avoid misuse of apprenticeships as cheap labour.
- d. Apprentices should have the same benefits as those of other workers, i.e., full coverage of social security.

6. Apprenticeship funding

- a. Assumed largely by firms, depending on each context.
- b. Some financial support offered by government, which may include tax incentives and assistance for disadvantaged.
- c. In some cases, shared costs between employers, apprentices and governments.

7. Eligible occupations for apprenticeship programmes

- a. Many occupations may be suitable to develop apprenticeships.
- b. Apprenticeships have been commonly associated with manufacturing, construction and trades, but are increasingly being used in the services sector.
- c. Frequently apprenticeship programmes focus on occupations required by the labour market, helping to address skills shortages and mismatches, as well as to develop new industries.

8. Appropriate education level to incorporate youth to apprenticeship programmes

- a. Students, graduates or workers with a quality basic education.
- b. A comprehensive knowledge basis of skills and competences, including literacy and numeracy skills, is necessary before entering vocational training. Lifelong learning and career development are important.

9. Key issues to ensuring labour market relevance of quality apprenticeship programmes

- a. Fostering a timely review of programmes.
- b. Ensuring qualifications and skills provided match evolving labour market demands.
- c. Providing skills that facilitate occupational mobility of apprentices.
- d. Encouraging continuous training.
- e. Fostering close collaboration, consultation, alliance and dialogue among relevant stakeholders, especially training institutions, employers, labour organisations, business stakeholders and professional associations.
- f. Continuous review of occupations and skills within each occupation to ensure relevance of apprenticeship learning.
- g. Effective pathways for entry, as well as assurance of high quality trainers and training provision of on-the-job and off-the-job mentoring.

10. A good career guidance-apprenticeship relationship

- a. Career guidance should provide information on the opportunities and benefits of vocational alternatives to further learning, including apprenticeships.
- b. Access to high quality career guidance and support could improve transition from school to further training, study or work.
- c. Labour market information systems are valuable tools to assist youth to make informed decisions.

11. Improving skills through apprenticeships

- a. In general, all skills that require theory and practice are improved through apprenticeship programmes.
- b. Practical, technical and specialized skills are especially developed through apprenticeships.
- c. Apprenticeship programmes should take into consideration an appropriate balance between specific and transferable skills.
- d. Transversal skills (which require an integration of several fields of knowledge and attitudes towards problem solving) are better acquired when the individual is confronted with real situations at the workplace.
- e. Apprenticeships also reinforce core skills such as problem solving, teamwork, communication.

12. An active role of business and labour organisations

- a. Promote active support of all the relevant stakeholders, particularly labour and business organisations, for the development, implementation and continuous improvement of high quality apprenticeship programmes.
- b. Encourage participation of business and labour organisations in the definition of training programmes.
 - i. Proposals for the creation, design and update of programmes.
 - ii. Identification of needs of a particular sector to facilitate targeted programmes.
- c. Foster role of trade unions towards ensuring the welfare and the rights of the apprentices, as well as their occupational safety and health.

13. Apprenticeships and the informal/ unorganised sector

- a. Apprenticeships may be a way for workers to enter the formal sector.

- b. A training body or commission could assess and recognize skills, capabilities and competences acquired in a non-formal or non-traditional way.
- c. A commission or body should set apprenticeship standards and supervise them.

14. Encouraging entrepreneurship through apprenticeships

- a. Apprenticeship programmes could develop entrepreneurial skills among youth.
- b. Entrepreneurial competences may be directed towards sectors where self-employment is prevalent (services, trades).
- c. Business incubators could assist to develop entrepreneurship among youth.
 - i. Business incubators may require stronger support to provide a more stable environment to youth to complete their training, including an appropriate supervisor, mentoring and the collaboration with other key stakeholders to provide additional learning and monitoring.

15. Promoting domestic follow-up of apprenticeship programmes

- a. Promote the recognition and validation of training through national bodies (commissions, committees), with the involvement of social partners, that certify qualifications and competences.
- b. When necessary, strengthen data on labour market outcomes of apprenticeship programmes.
- c. Review progress involving key stakeholders, according to national contexts.

16. Other key elements of quality apprenticeships

- a. Continue exchanging information and best practices at sectoral, national and international levels.
- b. Provide opportunities for apprentices to develop further, e.g. to gain higher qualifications and degrees.
- c. Foster adaptability, efficiency and affordability of quality apprenticeships.
- d. Develop apprenticeships in SMEs and sector-based approaches.

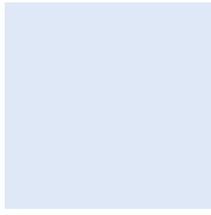
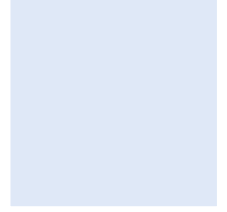
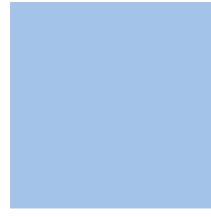
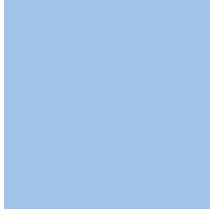
The Task Force considers apprenticeship programmes to be an efficient way for enhancing workers skills shortages, addressing skills mismatches and reducing youth unemployment.

The Task Force considers there is scope, subject to national circumstances, for the G20 countries to address one or more of the key elements listed above to scale-up, strengthen and improve the quality of apprenticeship programmes, as well as the development of evaluation tools.

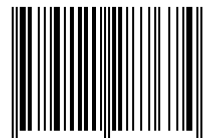
Ministers may wish to take account of the exchange of good practices on quality apprenticeships within the G20 Task Force and encourage further exchanges and follow up on this subject.

Individual countries could, on a voluntary basis, explore technical cooperation on quality apprenticeships.

Ministers may also wish to acknowledge the involvement of the social partners and encourage their efforts to foster agreements that promote and strengthen quality apprenticeships.



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