

THE BENEFITS AND COSTS OF **APPRENTICESHIP**: A BUSINESS PERSPECTIVE



November 2016





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Foreword



If our country is to out-compete and continue to lead the rest of the world, we must prepare our workforce for the jobs of the 21st century. Yet, in meeting more than 2,000 CEOs as Secretary of Commerce, the one challenge I hear over and over again is difficulty finding skilled workers.

Neither Government nor business alone can solve today's skills shortages or prevent new shortages tomorrow.

By building regional partnerships with education, workforce, and social service institutions, businesses and government can create training programs that connect workers with middle class careers. That approach is a hallmark of President Obama's workforce policy agenda.

Since the President issued the call to expand apprenticeships in his 2014 State of the Union, the U.S. has added more than 125,000 new apprenticeships, the largest increase in nearly a decade. Apprenticeships have gained new prominence as a proven training model for workers; but for businesses, apprenticeships have not necessarily been an easy sell.

This report harnesses the stories of 13 businesses and intermediaries that shared their experiences with apprenticeships. Through a careful analysis of their programs, it makes the case for apprenticeship from the business perspective. The cost of creating the programs varied from company to company, but all found that an investment in apprenticeship pays off.

Many of the companies in this study had open positions in their factories, medical centers, stores, and offices that they were persistently unable to fill. By turning to apprenticeships, they were able to broaden their pool of candidates and fill critical vacancies. Over the long run, the companies have found that developing talent through apprenticeships results in a more dedicated, flexible, loyal workforce that is poised to rise into leadership positions and make the companies more competitive.

The 13 case studies also suggest that, despite the clear payoff from apprenticeships, companies tend to give secondary attention to apprenticeships rather than embracing it as their first option for talent development. Companies use apprenticeship as a vehicle for developing workers for a few, hard-to-fill positions; they do not typically adopt it across their operations. This report provides evidence that should encourage more companies to consider starting or expanding apprenticeship programs in both traditional and new occupations.

I encourage all business leaders to read this report carefully. It makes it clear that apprenticeships are good for business.

Penny Pritzker
U.S. Secretary of Commerce

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Any errors in the report are solely the authors' responsibility.

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Executive Summary

In 2014, President Obama set out an ambitious goal to double the number of apprenticeships to 750,000 by the end of 2018, and to diversify them as well. This year the half million mark was passed. However, despite their increasing popularity and proven benefit to workers, apprenticeships are not fully understood in the United States, especially from the point of view of U.S. employers. The skilled trades that support our nation's construction industry still represent the core of American apprenticeships, but many other industries, like health care and information technology (IT), are adopting apprenticeships to create a skilled workforce for jobs they cannot otherwise fill easily, if at all. Along the way, firms are not only starting apprenticeships in new occupations and industries but also opening doors for women and minorities.

The basic components of apprenticeships are the same today as in 1937, when the National Apprenticeship Act set the foundation for apprenticeships in the United States. Apprentices enter into a structured training program of classroom and paid on-the-job training under the guidance of a mentor. As their skills increase, so do their wages. Upon completion of the program, apprentices earn an industry-recognized credential and usually are hired into a job that marks the start of a career. The payoff for workers is clear: 91 percent of apprentices find employment after completing their program, and their average starting wage is above \$60,000.¹ Because of these positive results, the U.S. Department of Labor (DOL) has invested \$265 million since 2015 to expand apprenticeships. Many states are increasing funding for technical assistance, tax credits to employers, and career and technical training to prepare students for apprenticeships.²

The biggest investment in apprenticeship programs, however, is made by businesses themselves. Yet surprisingly little is known about the payoff to businesses from these investments. Our study is one of a very few to examine these returns to business, and it attempts to avoid methodological issues common in the other studies. We examine 13 businesses and intermediaries from a variety of occupations, industries, and regions and ask: What motivated them to create apprenticeships? What are the costs and benefits? And if not apprenticeships, how else would they fill their workforce needs?

Within the apprenticeship framework, companies found great flexibility to adapt the model to their needs. As a result, apprenticeship programs vary significantly in length and cost. The longest program we studied lasted more than four years; the shortest, one year. Not considering start-up costs, the most expensive program in our sample of firms cost \$250,000 per apprentice; the least less than \$25,000. Apprentices' compensation costs over the duration of the program were the major cost for all companies, and together with program length were the major factor in the cost differences among the programs in our study. Other important costs were program start-up, tuition and educational materials, mentors' time, and overhead. One cost that was largely absent was the loss of apprentices from poaching by other companies; few companies noted poaching fears or reality.

¹ Perez, Tom and Jeffrey Zients. "ApprenticeshipUSA is Upskilling America." Department of Labor Blog. October 21, 2016. Available at: <https://blog.dol.gov/2016/10/21/apprenticeshipusa-is-upskilling-america/>.

² Schulz, Kelly and Ken Peterson. "#ApprenticeshipWorks for States." Department of Labor Blog. October 24, 2016. Available at: <https://blog.dol.gov/2016/10/24/apprenticeshipworks-for-states/>.

The companies in our study were unanimous in their support of apprenticeships. They found value in the program and identified benefits that more than justified the costs and commitments they made to the apprentices. Our study team worked with two firms to analyze in detail how company performance was tied to their apprenticeship program. Using internal production data, we analyzed certain productivity metrics to put a dollar value on some of the benefits these two companies reap from their apprenticeship programs.

- Dartmouth-Hitchcock in Lebanon, New Hampshire, found that apprenticeship was essential to a major expansion and re-organization of its provision of medical services. The apprenticeship program cost of \$59,700 per medical assistant (MA) apprentice was offset by a \$48,000 per-apprentice reduction in overtime costs and \$7,000 per apprentice in increased revenue from medical appointment bookings. The program nearly paid for itself within the first year and had an internal rate of return of at least 40 percent. In addition, reducing the long-term use of overtime helped relieve staff burnout and turnover. Our analysis also showed that the quality of care was at least as high after the MA apprentices were introduced.
- Siemens USA obtains at least a 50 percent rate of return on its apprenticeship program, compared to hiring machinists off the street. Most of the gains stem from the way that apprenticeship allows Siemens to more flexibly fill its capacity in Charlotte, North Carolina. The plant makes generators for electric utilities and seeks work repairing generators when it has capacity left over from making new products. Because apprentice graduates have a strong grasp of the principles of their work, they are particularly well suited for tasks like repair work, which involve more judgment than standard projects. Apprentice graduates' flexibility helps the plant make full use of its capacity. We find that this ability to perform a variety of tasks is enormously valuable. In fact, one year of this additional capacity is worth an amount similar to the cost of a worker's apprenticeship program. Apprentices also were more likely to finish their work on time and were slightly more productive than machinists hired off the street.

All of the firms we studied believe that apprenticeships improve their overall performance and provide a competitive advantage over other firms. Companies most often turned to apprenticeships because they could not find labor that met their minimum standards. We can measure the benefits to the apprenticeship model, which is often referred to as “earn and learn,” using three types of metrics:

- **Production:** Companies gain the value of output by apprentices and later by apprentice graduates, plus a reduction in errors.
- **Workforce:** Companies experience reduced turnover and improved recruitment, gain a pipeline of skilled employees, and develop future managers.
- **Soft skills:** Apprenticeships lead to improved employee engagement, greater problem-solving ability, flexibility to perform a variety of tasks, and a reduced need for supervision.

Certain employer decisions greatly affect program costs, benefits, and design, such as: program length, apprenticeship wages, training equipment, and program management. Whether companies work alone or in partnership with other businesses, educational institutions, unions, or non-profits also affects the start-up and ongoing costs. In the least expensive programs, employers often worked with the local public school system, especially in states that explicitly connected their career and technical training programs to apprenticeships. Grant funding also offset costs for some firms.

Once a decision has been made to include apprenticeships in a company's workforce strategy, the key to sustaining an apprenticeship program over time is to balance the interests of the employer, the apprentices, and the incumbent workforce. A successful program is one in which all three groups see benefits. It can be tempting for employers to focus too narrowly on their own short-term interests in structuring apprenticeship programs. However, to attract good apprentices, employers must offer a competitive package of current pay, portable credentials, and a relatively high probability of a good job. Similarly, incumbent workers also must benefit from having apprentices by seeing them as teammates helping the company grow and not as competitors for their jobs or promotion opportunities.

Companies generally recognized these multifaceted costs and benefits of apprenticeships but typically measured only some. Surprisingly few calculated the return on their firm's investment in their apprenticeship program. Because there is no existing toolkit for employers to measure the benefits and costs of apprenticeship programs and few firms explicitly collect data to do so, this report provides a roadmap to help employers get started.

Introduction

Throughout the history of the United States, apprenticeships have been used as a way to provide workers with specific occupational skills and a deep foundation of applied knowledge. Apprenticeships today are characterized by the “earn and learn” model where workers are paid to work while also receiving education. In the United States, apprenticeships are concentrated in the building trades—carpenters, plumbers, electricians, and so on—and particularly within unions; the Building Trades Unions have more than 1,600 training centers in the United States, with over \$1.3 billion of funding per year. Nearly two-thirds of all registered apprentices in the United States are in the construction industry.³

Employers in Europe, especially in Germany and Switzerland, widely use apprenticeships today and have institutionalized apprenticeships into their educational system. While the model of apprenticeship has not permeated U.S. industry or the educational system to the same degree as in Europe, U.S. employers outside of the building trades have begun to adopt the apprenticeship model for hiring and training workers. President Obama issued a call in 2014 for the United States to double the number of apprenticeships to 750,000 by the end of 2018, and with the number recently surpassing 500,000, the country is on the path to meet that goal. The 2016 fiscal year spending bill signed into law by the Obama Administration established the first-ever annual funding for apprenticeships in the United States.⁴ In fiscal year 2016, \$90 million was dedicated for expanding this pathway to skilled employment, on the heels of \$175 million in grant funds awarded in fiscal year 2015 for the American Apprenticeship Initiative.⁵ The apprenticeship-sponsoring companies currently registered in DOL’s ApprenticeshipUSA LEADERS (Leaders of Excellence in Apprenticeship Development, Education and Research) program represent a wide variety of industries, including construction, manufacturing, health care, finance, and even retail.⁶

A handful of studies have estimated the benefits of apprenticeships to American workers or society as a whole, but there is very little research that estimates how these programs affect American businesses. This study seeks to understand the costs and benefits of the training programs for a diverse set of LEADERS. From October 2015 through October 2016, our study team spoke with a variety of these firms on the phone and in person to learn about their experience with apprenticeships.⁷

³ Data provided by the DOL Office of Apprenticeship. For more information on apprenticeships in the construction trades, see the North American Building Trades Unions (NABTU) brochure on apprenticeships. Available at: <http://www.bctd.org/BCTD/media/Files/BCTD-Appren-Four-YR-Degree-2015.pdf>. See also our case study of NABTU sponsored apprenticeships in this report.

⁴ The White House. FACT SHEET: Investing \$90 Million through ApprenticeshipUSA to Expand Proven Pathways into the Middle Class. April 21, 2016. Retrieved from: <https://www.whitehouse.gov/the-press-office/2016/04/21/fact-sheet-investing-90-million-through-apprenticeshipusa-expand-proven>.

⁵ For information on ApprenticeshipUSA grants see: <https://www.dol.gov/featured/apprenticeship/grants>.

⁶ See DOL’s ApprenticeshipUSA webpage to read more about LEADERS. Available at: <https://www.dol.gov/apprenticeship/leaders.htm>.

⁷ We asked all firms to review the case studies for factual errors. We also asked some to provide additional information in order to fill remaining gaps in our understanding of their apprenticeship programs. All results and opinions in this study are our own.

Our study began with phone conversations with companies or other organizations drawn mostly from DOL's LEADERS program. Some of these organizations are firms that run apprenticeship programs, including:⁸

- Blue Cross Blue Shield of South Carolina
- CVS Health
- Daetwyler Industries
- Dartmouth-Hitchcock
- Dr. Schneider Automotive Systems
- Ford Motor Company
- Hypertherm
- MTU America
- Oberg Industries
- Siemens USA

Other organizations in the LEADERS program facilitate apprenticeships or otherwise partner with firms. We also spoke with several of these organizations, including:

- American Federation of Labor and Congress of Industrial Organizations (AFL-CIO)
- Apprenticeship Carolina
- International Union of Painters and Allied Trades (IUPAT), a member of North America's Building Trades Unions
- IT-ology
- LaunchCode
- National Institute for Metalworking Skills (NIMS)
- North America's Building Trades Unions (NABTU)
- Service Employees International Union (SEIU)
- United Auto Workers (UAW)
- Vermont HITEC

Based on interviews and site visits, this report includes 13 profiles of organizations actively involved in administering successful apprenticeship programs. We profile firms, consortia, an educational institution, and others. We have also included two quantitative case studies that examine the relative benefits of apprenticeships versus other staffing options. Together, the profiles and case studies have led us to identify a series of critical decision points that bear significantly on the costs borne and benefits reaped from apprenticeships. We also outline how companies—whether they are considering an apprenticeship program, just starting one, or with one well underway—should measure the costs and benefits of their program.

This report presents our findings from this study and consists of four parts:

1. Overview of apprenticeships
2. Major decision points (for implementing apprenticeships)
3. Roadmap to measurement
4. Case studies⁹

⁸ In addition to these firms, we also spoke with Buhler Aeroglide Corporation, Denso, Huntington-Ingalls, Mohawk Industries, and Precyse (now n thrive).

⁹ Appendix I provides additional background on the statistical techniques used to analyze the benefits of apprenticeship to two companies. Appendix II reviews the literature on the return on investment to apprenticeships for employers.

What is an Apprenticeship?

Apprenticeships are available in a variety of occupations, including both traditional fields and newer ones such as mechatronics, cost estimation, computer simulation, banking, medical coding, and pharmacy operations. In all, the DOL Registered Apprenticeship (RA) program covers over a thousand occupations.¹⁰ Many, though not all, of these programs are small and fairly new, with their apprentices only recently graduating into the workforce.

DOL defines an RA program as “innovative work-based learning and post-secondary earn-and-learn models that meet national standards set by DOL (or federally recognized State Apprenticeship Agencies).”¹¹ Programs in DOL’s RA have five defining features:

1. Participants are paid by employers during training.
2. Programs meet national standards for registration with the U.S. Department of Labor (or federally-recognized State Apprenticeship Agencies).
3. Programs provide on-the-job learning and job-related classroom or technical instruction.
4. On-the-job learning is conducted under the direction of one or more of the employer’s personnel.
5. Training results in an industry-recognized credential that certifies occupational proficiency.¹²

At a minimum, for an apprenticeship program to be registered with DOL, it must combine classroom instruction with paid on-the-job training that teaches workers practical skills, and the full apprenticeship must last at least one year. The classroom training is usually tuition-free to the apprentice. Many of the companies with whom we spoke also pay hourly wages or a flat stipend to the employee for their classroom time. Some firms provide all classroom training in-house and some partner with local community colleges to outsource this training while providing hands-on training at the company. Others partner with other firms to form consortia, like Apprenticeship 2000 or the North Carolina Triangle Apprenticeship Program (NCTAP), to provide classroom training to apprentices across several firms all at once.

Additionally, each apprentice is paired with a mentor who takes time from his or her regular duties to guide the apprentice’s acquisition of technical skills and help integrate the apprentice into the company. Through this, the mentor passes on practical knowledge. The mentors with whom we spoke took pride in this role and reported that serving as a mentor helps reinforce their skills and gives them a new appreciation and purpose for their job.¹³

When apprentices graduate from an RA program, they earn an industry-recognized credential from DOL or the state apprenticeship agency. Depending on where the program is registered and the occupation, this may be, for example, a national or state occupational certification or a journeyperson’s certificate. Many of

¹⁰ See DOL’s ApprenticeshipUSA FAQs. Available at: <https://www.dol.gov/featured/apprenticeship/faqs>.

¹¹ See DOL’s ApprenticeshipUSA webpage. Available at: <https://www.dol.gov/featured/apprenticeship>.

¹² DOL’s ApprenticeshipUSA FAQs.

¹³ It is important to distinguish between mentor and manager. Although the mentor may also be the apprentice’s supervisor, the roles and responsibilities of each are distinct. The supervisor provides administrative oversight and may or may not have experience in the apprentice’s occupation. The mentor oversees the apprentice’s on-the-job training as an experienced worker in that occupation.

the programs in our study also provided apprentices the opportunity to earn a secondary or post-secondary academic degree or credits, an industry certification, or a state or local license.¹⁴

Other types of work-based learning share many of the elements of apprenticeships. Apprenticeships and internships both provide work experience, for example. Apprenticeships and other types of on-the-job training both involve formal, paid hands-on training, and on-the-job experience sometimes includes formal classroom lessons like apprenticeships. Apprenticeship is not just work experience, and it is not just on-the-job training to do a specific task. A true apprenticeship provides a formal structure and rigor to classroom and on-the-job training under a mentor and with pay progression that ends with an apprentice graduating with a certification (and in some cases, multiple certifications) that he or she is fully proficient to do a job. Furthermore, the apprentice is ready for a job and, in the vast majority of the cases, transitions directly into permanent employment.

Why Apprenticeship?

There are many reasons why a firm might choose apprenticeship as a model. Many firms have difficulty finding the skills they need in the open job market; for example, their employees may be required to have a high level of company-specific knowledge that often cannot be found in the labor market. The need for skilled workers was the most common factor cited by the companies in our study. Buhler Aeroglide, Siemens, and Max Daetwyler Corporation (Daetwyler)—three European-based manufacturing firms with plants in North Carolina—told us that without their apprenticeship programs it would be extremely difficult to find workers with the skills they are looking for in the local labor market. In some cases, employers leave positions vacant, requiring them to turn down work or deliver products late.

Apprenticeships may also reduce hiring costs by providing a streamlined channel to bring on new workers. Apprenticeships may reduce attrition by building a bond of loyalty between company and employee or by providing an opportunity for motivated young people to stay rooted in their communities. Dartmouth-Hitchcock, a large hospital in New England, cited unfilled positions, increased overtime, and a desire to avoid having to reassign doctors to administrative tasks as key reasons for instituting an apprenticeship program.

Several companies we interviewed for this study also noted that apprenticeships often lead to faster advancement in the company, helping the firms to develop their future leaders. Siemens cited the need for a pipeline of workers who could be cross-trained in multiple functions and graduate into leadership. Siemens also felt that the apprenticeship program allowed it to recruit better employees than it would otherwise because of the chance for apprentices to earn a valuable skill debt-free. Blue Cross Blue Shield of South Carolina (BCBSSC) estimates that 22 percent of graduates from the apprenticeship program are currently serving in leadership roles.

¹⁴ According to the Association for Career and Technical Education, “industry-recognized” credentials are:

- a. sought or accepted by employers within the industry or sector involved as a recognized, preferred, or required credential for recruitment, screening, hiring, retention or advancement purposes; and
- b. where appropriate, endorsed by a nationally recognized trade association or organization representing a significant part of the industry or sector.

Examples include the National Institute for Metalworking Skills certificates in machining and die-making and the CompTIA Security+ and Healthcare IT Technician certificates. See <https://www.acteonline.org/WorkArea/DownloadAsset.aspx?id=1917>.

Registered Apprenticeship? What and why?

Most of the organizations in our study have chosen a common partner in administering their apprenticeship programs—the government. They have partnered with DOL's Office of Apprenticeship or a state apprenticeship agency (recognized by DOL) by registering their program. As noted earlier, DOL has identified over a thousand occupations for registered apprenticeships.

A sponsoring organization for apprenticeship can be a single business or consortium of businesses, an industry association, joint labor-management organization, community college, community-based organization, or other organization that assumes responsibility for the overall operation of the apprenticeship program. To register, one of these sponsor organizations submits detailed documentation, called “standards,” on the apprenticeship program for a specific occupation to DOL or the state agency for review and approval. The standards documents demonstrate that an apprenticeship meets the five-part definition described earlier by listing the occupational competencies, curriculum, wages and hours of work, applicant qualifications, and duties and responsibilities of the apprentices, sponsor, and mentors. The sponsors also demonstrate how the program meets regulatory requirements related to apprenticeship training, as well as Equal Employment Opportunity in the selection of apprentices. Registration also guarantees that apprenticeship graduates will receive an official credential from the U.S. Department of Labor or state apprenticeship office, which helps attract potential candidates to the program, thereby reducing recruitment costs.

Working with DOL or a state apprenticeship agency to develop and register an apprenticeship program can provide tangible benefits to the company and reduce various costs for the business or other sponsoring organization. DOL can reduce start-up costs by providing technical assistance in the preparation of a company's training plan, including structuring the apprenticeship program, preparing the on-the-job training outline, and finding educational or other partners to help design and implement the program. By partnering with intermediaries or other companies, as well as by accessing Federal and state funding streams to support apprenticeships, a firm may be able to reduce its apprenticeship program's costs, such as apprentice wages and tuition. In some states, registration also opens the door to tax credits and other state funds that may help defray the costs of each apprenticeship.¹

As DOL and states seek to expand registered apprenticeships, they have made the process simpler and more transparent—starting with an online registration tool at: <http://doleta.gov/oa/registration/>. DOL encourages companies considering apprenticeships to contact them for assistance early in their deliberations.

¹ See DOL ApprenticeshipUSA website for information about states which offer tax credits to employers for hiring apprentices and tuition support for registered apprentices at: <https://www.doleta.gov/oa/taxcredits.cfm>.

Similarly, Buhler Aeroglide told us that apprentices who move into management or engineering roles will be more effective because they will have detailed knowledge about operations on the factory floor and a rapport with other employees.

For workers, apprenticeships may be an attractive way to earn an industry-recognized credential or degree as an alternative to a four-year, traditional university, trade school, or community college. Apprenticeships offer workers occupational-specific training, providing a pathway into a career and higher earnings.

Methodology

Through our discussions with firms and organizations acting as intermediaries for apprenticeships, we found evidence of these benefits in action. Because we wanted a diverse picture of how apprenticeships are being used in the United States, we chose to contact organizations across a variety of industries, occupations, regions, and firm sizes. However, we acknowledge that the study group is not representative of all firms that have considered or started apprenticeship programs. These are companies that, by definition, have programs where the perceived benefits outweigh the costs. Our goal was to understand the motivation for beginning their apprenticeship programs and the analysis that underlies their decisions to continue the programs. We spoke principally with senior managers in human resources and talent development as well as production managers. These conversations formed the bulk of the material presented in this study, providing an overview of the kinds of apprenticeships offered in the United States, their evolution over time, and how companies view their roles as sponsors of these programs, as well as their successes and challenges.

From these discussions, it was evident that there is a lot of qualitative evidence that apprenticeship is good for employers. However, it also became evident that most firms do not compile and analyze comprehensive cost and benefit data that allows them to carefully measure the return on their investment in these programs. Most firms were able easily to provide information on costs, such as the cost of hiring in the absence of an apprenticeship program or the cost of training and educating one apprentice. Only a few firms with whom we spoke were able to provide clear quantitative data on the benefits they identified from their apprenticeship programs. One barrier to doing so was that key benefit data would be derived from their production metrics, while cost data would reside in human resources or payroll, and firms did not on their own blend those data sets to examine how their productivity measures related to how workers were hired and trained. The few firms that did have benefit data weighed it against program costs, and one even went as far as calculating a measure of return on investment (ROI) for apprentices versus other hires. Such complete analysis, however, was not the norm.

Following initial calls, we visited several firms based on the prospect of those companies having data available for calculating ROI and their willingness to share their data. At each of these firms, we conducted on-site interviews with staff, program officers, apprentices, mentors, program graduates, and data managers to gather detailed information about the programs, their operation, and how they are understood by those directly engaged with them. We also discussed in detail how apprenticeships fit into their broader hiring strategies to understand the motivation for using apprenticeships versus trying to hire skilled workers—the goal being to examine the ROI of using apprenticeship relative to the ROI from other methods of filling the need for



workers. Two firms worked very closely with our study team and provided a large amount of data we used to analyze firm-specific benefits from their apprenticeship programs, specifically productivity measures with and without apprentices.

Case studies for the two firms we visited and the eleven other organizations that we interviewed comprise the final section of this report. Although our findings cannot be generalized for all firms, the process provides a framework for further study and lessons learned for future teams working in this field. We present the full statistical results from our in-depth analysis of Siemens and Dartmouth-Hitchcock in the appendix.

Major Decision Points

Several common decision points emerged as the organizations to whom we talked shared their experience with starting and administering apprenticeship programs. Their collective experience led us to seven questions for firms to consider when designing a new apprenticeship program or analyzing the costs and benefits of an existing one.

1. Is apprenticeship integrated with your production and other strategic priorities?

Successful firms typically have talent strategies that are closely integrated with their strategies around production, technology, and marketing.¹⁵ In some cases, technology is the driver, and workforce strategy follows. For example, in Germany, Siemens developed a precision product and the technology needed for production. This requires a highly-skilled workforce, which in Germany is largely supplied through the nationwide apprenticeship program. Siemens brought this production process to the United States and required similarly-skilled production workers, leading to the North Carolina plant's apprenticeship program. At Dartmouth-Hitchcock, the decision to create a medical assistant (MA) apprenticeship program was driven by cost pressures and changes in the U.S. health care system, such as greater emphasis on teamwork and electronic medical records. These changes led the hospital to redesign work in a way that placed greater reliance on MAs.

In other cases, however, a firm's workforce strategy drives its technology or marketing strategies. For example, CVS Health's (CVSH's) apprenticeship program is instrumental to the company's desire to have a workforce as diverse as its customer base. Oberg sees itself as "selling skill" more than manufactured goods. Its skilled workforce can "make the machines sing and dance," allowing the firm to operate advanced machinery and tackle complex jobs that other firms cannot.

In short, firms should maximize the value of apprenticeships by not only looking at the program as a means of finding workers for today's hard-to-fill jobs.

2. Where does apprenticeship fit in your overall talent development strategy?

Firms find and develop talent through multiple channels. Apprenticeship is a proven path that pays off for workers in terms of employment and wages, and all the companies we studied consider that it also pays off for them. But it is by no means the only option, even for these companies.

Most companies use various other approaches to fill openings for jobs where they also use apprentices. Some find skilled workers locally, recruit experienced workers and put them through short-term training, bring on contractors or workers from temporary staffing firms, or distribute job tasks across other workers in the company. The true cost and benefit question these companies face is not just whether apprenticeships pay off, but if they are better than the other alternatives—and what this implies about the ideal share of apprentices for each job category.

¹⁵ Thomas Kochan, *The Future of Work*. Cambridge, MA: MIT Press, 2016.

Apprenticeships, however, offer unique benefits as a talent development strategy.

- **Apprenticeships provide workers with both practical skills and an understanding of fundamental principles.**

Because apprentices understand the principles behind the work they are doing, they are often more adept at problem-solving, can adapt to new technologies, and can operate with less supervision than employees who are not apprentice graduates. For example, at Siemens, an apprentice was able to figure how to set up a job that had stymied his own mentors. He fabricated three new metal components to use in the setup of a machine, something he was able to do because he understood principles of physics and was able to program the machine tool in addition to watching it run.

- **Apprenticeships expand the pool of skilled workers in locations where firms cannot find the workers they need.**

Dartmouth-Hitchcock's relatively remote location, along with a small labor market with few local graduates from related associate's degree programs, made it difficult to find local workers who were willing and able to take on the required duties of an MA. Fully trained MAs were not typically willing to commute or relocate for the same pay they were already earning elsewhere. To the extent that apprentices earn good wages and graduate without debt, the program may allow a company to recruit a higher quality worker, one who is willing and able to combine classroom training with hands-on learning.

- **Apprenticeships help firms target specific groups of job candidates, such as younger or older workers, women, minorities, and veterans.**

Siemens has both a youth apprenticeship program as well as one for veterans. LaunchCode has trained and placed IT apprentices from age 16 to age 65. For CVSH, apprenticeships offer a strategy to reach and prepare workers who face educational and other barriers that leave them on the margins of the labor market.

- **Apprentices can be trained into a company's work and culture.**

Firms often have a specific way of doing things. The long and intense training period of an apprenticeship helps workers absorb these methods intuitively. Hypertherm found its computer numeric controlled (CNC) machinist apprentices were so productive that it decided to put all of its incumbent machinists through the same program to refine the skills that the firm values.

Apprenticeships are an attractive option for a particular occupation when the features above are particularly valuable to a company. DOL publishes a list of occupations with existing registered apprenticeship programs; that list should be seen as a starting point, since the variety of jobs with apprenticeships continues to increase.¹⁶

¹⁶ For more information, see: <https://www.doleta.gov/oa/occupations.cfm>.

3. What value can partnerships provide?

Nearly all of the apprenticeship programs in our study involve some form of partnership between the company and another organization. Most frequently the partner organization is a union or an educational institution. Companies have formed consortia with other businesses and contracted with non-profit intermediaries. DOL or the state apprenticeship office often helps build these partnerships.¹⁷ Partnerships create economies of scale and facilitate sharing of expertise. They reduce the sometimes substantial start-up costs related to curriculum development, staff training, purchasing equipment and training materials, and acquiring classroom space. Partnerships with secondary schools and public community colleges effectively reduce tuition costs by leveraging the public educational system.

Industry consortia

Curriculum development, recruiting, program administration, and apprentice classroom instruction can seem prohibitively expensive for a small firm with few and infrequent openings. Furthermore, setting up and administering an apprenticeship program is time consuming for any firm. Firms needing workers with similar skill sets have joined together to form regional industry consortia like Apprenticeship 2000 and the North Carolina Triangle Apprenticeship Program (NCTAP) where each firm is responsible for contributing to the administration of the program. Representatives from each firm in the consortia work together to start up the program and then jointly conduct marketing and recruiting activities as the program continues. Once a consortium is established, new firms make an initial payment to join and pay a flat annual fee thereafter. For example, firms pay \$3,000 to join NCTAP and then pay a total of \$500 to \$1,000, regardless of the number of apprentices they hire, each subsequent year to maintain their membership. In addition to the fees, firms pay the wages and tuition expenses for each apprentice they hire.

The firms with which we spoke felt that dues paid to consortia was money well spent. The cost of recruiting apprentices is substantial, especially when apprenticeship programs are first introduced in a region or for an occupation for which no program existed before. When this is the case, the basic concept of apprenticeship must be explained to potential young workers and often their parents. Firms and paid consortium staff can divide up the work of developing and disseminating marketing materials and attending career fairs at area schools.

¹⁷ For more information, see the box note on “Registered Apprenticeship What and Why?”

Illinois Consortium for Advanced Technical Training (ICATT)

Although not part of this study, the Illinois Consortium for Advanced Technical Training (ICATT) illustrates the variety of forms consortia and partnerships can take. The ICATT dual vocational training program was established by the German American Chamber of Commerce of the Midwest, the Illinois Manufacturers Association Education Foundation, and William Rainey Harper College in 2014.ⁱ In 2015 ICATT launched its pilot cohort at Harper College. Currently it has established apprenticeship programs with 12 manufacturing firms and 4 community colleges as partners across the state (two in the Chicago area and two downstate in more rural locations). Current programs are for industrial maintenance technicians and CNC machinists. Apprentices take part in an accredited three-year program, in which they will receive an associate's degree in advanced manufacturing along with German industry certification and other accreditation.ⁱⁱ

All companies offer essentially the same terms, including full community college tuition for classroom training, paid on-the-job training (with increasing wages) at the company, and a job guarantee for two years upon successful completion of program.ⁱⁱⁱ Each participating company pays a management and administration fee; currently, this is an initial contribution of \$2,500 plus a recurring annual participation fee of \$2,500 for each apprentice. The annual fee is capped after the third apprentice so that the total annual fee for employers does not exceed \$7,500 in any given year.

ⁱ Headquartered in Chicago, with a branch office in Detroit, GACC Midwest's mission is to promote the expansion of bilateral trade and investment between Germany and the United States, especially the Midwest, via the official representation of German companies, membership and consulting services. The ICATT program is detailed at www.thinkicatt.com.

ⁱⁱ The German certification is from the Association of German Chambers of Commerce and Industry (DIHK/AHK) and is identical to that earned by apprentices in Germany. Graduates also earn a DOL Registered Apprenticeship Certification and have the option to earn multiple certificates from the National Institute for Metalworking Skills.

ⁱⁱⁱ Apprentices that leave the program early or are terminated by the company for just cause must reimburse the company for all funds paid toward tuition and stipend.

Another feature of consortia can be a shared classroom. Apprentices from several different firms attend part-time classes together at the community college or other educational institution associated with the consortium. Apprentices then spend the rest of the week in on-the-job training with the firm that recruited them. This arrangement makes it possible for firms with very few apprentices to offer formal classroom training with a specific occupational curriculum, a scenario that may be prohibitively expensive for just one or two students.

An additional benefit of consortia is that they reduce both the danger and cost of poaching, a practice in which a firm hires a skilled worker away from another firm that has invested in the workers' training. Successful consortia create a pool of skilled workers in the local labor force with widely-recognized credentials. This situation is good for workers, who can advance in their careers by changing to a new firm if a promotion opportunity is not available at their original firm. It is also good for employers, who may find it beneficial to hire mid-career workers. Employers may not be able to retain a worker they have trained for his or her entire career, but all firms in the local market can benefit from access to workers that others have trained.

Unions

Labor unions like the United Auto Workers (UAW) and North America’s Building Trades Unions (NABTU) house registered apprenticeship programs for their members. These programs have substantial benefits for employers as well, particularly for small firms or firms that need workers with certain skills only for short periods of time. As our case study of NABTU points out, construction is “the original gig economy,” where workers work on any given project for only a short period. The Construction Industry Craft Training Research Team estimates that NABTU employers earn a return of between \$1.30 and \$3.00 for every \$1.00 invested in craft training due to improved safety, increased worker productivity, and reduction of rework, absenteeism, and turnover.¹⁸

A union, in cooperation with employer associations, can provide a structure for training workers and matching them with employers. It is difficult for individual small employers to keep up with new developments in technology; joint training centers have staff that ensure that new skills (e.g., installing fiber optic cable or solar panels) are incorporated into apprentice training and continuing education. The structure also avoids the poaching problem discussed above; employers do not get access to trained workers unless they pay their share of training costs. Meanwhile, employers do not have to pay for a worker whose skills are not currently needed; the union maintains a hiring hall that matches employers with needs and jobseekers with specific skills.

In addition, union involvement can ensure that the training remains relevant to the day-to-day tasks workers actually perform, rather than an abstract curriculum that may not reflect their real-world activities. Finally, collective bargaining can provide a structure in which disputes are resolved and a balance of benefits is maintained. For example, key to the 100-year history of the building trades apprenticeship is the maintenance of an intergenerational bargain, in which mentors, apprentices, and employers each receive enough benefits to want to continue with the arrangement.

Intermediaries

Non-profit intermediaries like Vermont HITEC and LaunchCode provide a fee-based option for firms to access or develop an apprenticeship program. While firms must still hire and provide on-the-job training to the apprentices, they can pay the intermediary to provide other services such as recruitment and screening, curriculum development, and classroom training associated with the apprenticeship program.

For example, LaunchCode is a nonprofit organization that helps workers develop the proper skills needed to enter into IT coding positions as apprentices. LaunchCode handles curriculum development, recruiting, screening, and training for the firms with whom they work. Only after candidates are deemed proficient in the IT skills needed by employers does LaunchCode work with firms to place qualified candidates into open positions. LaunchCode bills firms \$5,000 after apprentices are fully converted to permanent employees; this is the only explicit non-wage cost that firms have under this arrangement.

Community colleges can also serve as intermediaries for firms by convening firms and by sponsoring apprenticeship programs. One role that is more common for community colleges is to help firms develop and deliver classroom curriculum for apprentices, as we discuss below.

¹⁸ “Construction Industry Craft Training in the United States and Canada,” Construction Industry Institute, University of Texas, Research Summary 231-1, August 2000.

4. How should you develop and deliver the classroom curriculum?

A rigorous, well defined curriculum is essential to apprenticeships. Apprentices need formal training in both technical, occupation-specific skills and in soft skills, such as teamwork, communication, and professionalism. If a firm is not joining a consortium that already has a defined curriculum, developing the curriculum and determining how best to deliver it can be the most daunting parts of starting an apprenticeship program.

The companies we studied vary greatly in how they build their curriculum and conduct the training, and their approaches have evolved over time. Some conduct their classroom training on-site with contracted instructors; for example, CVSH provides classroom training to its 1,500 apprentices in its own classrooms with nationally certified trainers who are CVSH employees. It follows a unique five-section curriculum with 20 to 30 competencies in each section. Other firms blend in online classes while many work with a community college, often aligning their curriculum with existing degree programs so apprentices can receive college credit, if not a degree, upon finishing the apprenticeship. Rather than work with community colleges to meet its curriculum needs, Dr. Schneider Automotive Systems takes advantage of a statewide pre-apprenticeship program through Kentucky's high school and secondary vocational schools.¹⁹

When companies choose to use a curriculum linked to an academic program or an industry-recognized certificate, such as BCBSSC's use of CompTIA's Healthcare IT Technician certificate program, graduates can earn an additional portable credential beyond the certificate issued by DOL. These credentials signal to the firm providing the apprenticeship, and other potential employers that the graduated apprentices have acquired a specific skill set. Credentials can also make these programs more attractive to potential recruits who want to continue academic or professional training after the apprenticeship. Dr. Schneider cited a state-based certification as particularly important because there is no existing associate's degree program for the mold-setter occupation. CVSH apprentices earn both national, industry-specific and company-specific credentials.

5. What are the best ways to implement on-the-job training and incorporate apprentices into the workplace?

Well-developed on-the-job training (OJT) is as important as the foundational classroom work. It is through this part of the program that apprentices gain the firm-specific skills that make them valuable members of the workforce. The single most important element of OJT is the apprentice-mentor relationship (the fourth point in DOL's definition of apprenticeship). Mentors should be trusted, relatively senior members of a firm's workforce who are able to help apprentices apply their technical skills to their assigned tasks and also introduce apprentices to the company's culture.

Mentors also help apprentices learn how to conduct themselves in the workplace and how to work with others to get the job done. Many apprentices are young adults or even teenagers who have never been in a professional work environment; mentors are key for helping them understand the etiquette and expectations of that world. Because these soft skills are so essential, some firms offer pre-apprenticeship training in them. CVSH partners with community organizations to offer initial soft-skills training to candidates before they start the apprenticeship to help prepare them for the transition into the corporate world.

The exact way in which mentors and apprentices are paired varies from company to company, but each apprentice should have one mentor responsible for his or her training at a time. Some firms rotate apprentices through multiple mentors over the course of the program. How a firm assigns mentors to apprentices might

¹⁹ For more information on the Tech Ready Apprentices for Careers in Kentucky (TRACK) program, see: <http://education.ky.gov/cte/ctcr/pages/track.aspx>.

depend on a firm's work processes or on employees' work schedules. Some firms know in advance how they will use the apprentice within their firm and for what work processes the apprentice will be responsible. Others use the apprenticeship period to test their new employee's skills in order to later assign him or her tasks.

If the apprentice-mentor pairing proves to be a poor fit—whether because of different skill sets, training needs that a particular mentor may not be best suited to provide, or even personality conflicts—then the company should act quickly to find a new mentor. Getting the mentor-mentee relationship right is critical to the success of the program. As described above, companies take many steps to ensure that apprentices they bring on are qualified and have an excellent work ethic. Making sure the OJT component of the program works well is key to ensure that companies are holding up their side of their bargain to prepare apprentices for careers. While this study examines the investment and commitment of companies doing apprenticeships, it is important to remember the considerable commitment and investment of the apprentices in the companies they choose, too.

Mentors with whom we spoke were honored to be chosen to train others. They also spoke of a renewed interest and focus in developing their own skills. Additionally, mentors and apprentices to whom we talked shared that they gained a sense of belonging to the workplace family by participating in this type of relationship. Nonetheless, the time spent on the clock teaching others is time away from regular production work, so mentors deserve recognition for this contribution to the company's long-term success and should perceive a benefit from participating in the program.

Finally, companies need to consider thoughtfully how apprentices will be incorporated into their existing workforce. Doing this well requires balancing the interests of the employer, the apprentices, and the incumbent workforce. Apprenticeships must prepare workers for good, stable jobs with the company, with compensation on par with the existing workforce. The incumbent workforce—not just the mentors—should see the value of having apprentices and consider them teammates, not competitors for their good jobs or promotion opportunities. Likewise, apprentices should not be seen as a cheap or temporary substitute for skilled labor, but rather as workers early on the career ladder who soon will be equal colleagues.

6. How do you decide between a competency-based and a time-based apprenticeship program?

As discussed, apprentices gain general technical knowledge and firm-specific knowledge about an occupation through a combination of classroom and OJT. In some programs, firms validate the acquired skills and competencies of apprentices either through competency-based testing or completion of program milestones. Wage increases are often based on the competency level that the apprentice has reached. The time to complete competency-based programs can vary; for example, at CVSH, apprenticeships last from one to two years depending on how long it takes for an apprentice to learn the skills required.

On the other hand, in time-based programs, the length of the program is fixed. The time-based programs we examined ranged in length from one year to more than four years, reflecting the differing levels of time needed to impart classroom training and to train apprentices fully in job-specific skills.

Most of the programs we studied were competency-based. Siemens, however, favors a time-based program, with apprentices alternating classroom and OJT throughout the four-year program. For Siemens, the relative youth of its apprentices led the company to prefer a time-based approach. The company realized that maturity and professionalism were just as important as technical skills and that these attributes could not be effectively measured with a pre-entry test. Consequently, Siemens decided to use a time-based program, which provides ample opportunity to mature in a professional environment.

7. How many apprentices do you need?

Once a firm has paid the upfront costs of establishing a program, it should hire apprentices as long as the benefits of having one more apprentice are greater than the additional cost of that apprentice. Calculating these benefits and costs is not easy, especially when a firm is just starting its program. Below, we discuss some factors firms should consider in initially determining how many apprentices to bring on: future labor needs, probability that apprentices will complete the program, cohort effects, and company time horizon.

Future labor needs. Firms such as BCBSSC use a sophisticated, annual planning process to determine how many apprentices to hire each year. Future labor needs matter most in this process, but companies also need to consider the share of jobs they want to fill with apprentices and how long apprentices are likely to stay in a job before being promoted or leaving the company.

Probability of completion. Like any employee, apprentices might leave a program for a variety of reasons: for some, the program or firm might be a bad fit; some leave for personal reasons; and others leave to take another job or go back to school full-time. Whatever the reason, non-completion creates a sunk cost that firms must take into account when determining how many apprentice hires to make. BCBSSC estimates that one out of ten of its apprentices leaves the company before completing the apprenticeship.

Firms can increase the probability of completion by trying to get a good fit between apprentices and the firm at the time of hire. At Daetwyler, the non-completion rate has fallen from 35 percent to zero since 2013, as the company has gained a better understanding of the type of candidate that will succeed in their program after having run the program for a few years. Siemens instituted additional screening, including a six-week paid internship, to ensure that potential apprentices understood the commitment they were making; turnover has fallen as a result.

As we discussed earlier, another potential source of attrition is that apprentices may be “poached” by employers who have not made such an investment. In practice, this was not a major problem for our interviewees. They avoided the problem in several ways. First, they paid attention to a balance of benefits (e.g., making sure wages of apprentices are commensurate with their value to the firm). Second, they participated in consortia. As discussed above, consortia reduce both the probability of poaching and the cost to firms if it does occur (since firms have a bigger pool of trained workers from which to draw, and thus may sometimes be the beneficiary of workers that another firm has trained). Firms that are more concerned about losing their apprentices require apprentices to agree to pay back their training costs to the firm if they separate before completing the apprenticeship. Furthermore, apprentices at Siemens and BCBSSC sign an agreement that they will pay back training costs if they leave the firm less than two years after completing the program.

Cohort Effects. MTU America sees value in creating a cohort of about six apprentices each year, regardless of its plans to transition the apprentices to permanent employment, and it does not guarantee a job to graduates. It can do so because it finds that the apprentices provide a positive return to the company during the apprenticeship program, and it believes in adding new skilled workers to the local labor force whether they are working for MTU or another company. Like MTU, all study participants stressed the value of the strong bonds that apprentices developed with others in the same class. The apprentices with whom we spoke mentioned the value of having more senior apprentices to whom they could ask questions they were less comfortable asking management.

Programs with just a couple of apprentices or that do not recruit new apprentices each year are likely to lose these cohort benefits. That said, smaller programs can succeed. Dr. Schneider has just a handful of apprentices, which it is able to do because the students are well integrated in an existing pre-apprenticeship

program in the local schools. Consortia have a similar effect in that apprentices from several firms attend classes together, creating inter-firm cohorts.

Time horizon. Some firms focus on recouping their investment during the term of the apprenticeship. However, such a focus may create an incentive for firms to treat the apprenticeship program as a short-term, low-wage labor program, causing these firms to sacrifice training time for production. These tactics diminish the long term returns to apprenticeship programs by reducing the quality of people wanting to enter the program or reducing the skills they gain while in the program. While most companies in the study guaranteed graduates a permanent job, BCBSSC and Siemens went a step further by requiring graduates to stay with the company two additional years, as noted above.

In some cases, back-of-the envelope calculations make a compelling case for the in-depth training an apprenticeship provides. At Siemens, the cost of scrapping defective product is very high, so if defect reduction would occur as a result of apprentice training, Siemens could recoup its costs very quickly. At CVSH, apprentice programs meant that the firm could hire people from neighborhoods near its stores, diversifying its workforce in many ways. This had an additional benefit for CVSH as this workforce program led to an increase in customer loyalty.²⁰

For these reasons, most of the firms in our study bring on apprentices with the intent to move them into permanent positions after they complete the program. Siemens, BCBSSC, and CVSH all base their decisions about how many apprentices to hire on long-term labor force needs. It is critical for companies to hire apprentices with an eye toward the long-term in order to avoid the perception that apprentices are low-wage, temporary workers in the company.

However, the point at which the net cost of the apprenticeship program turns into a net benefit is not something that the study firms tend to measure, in part because the data needed to do so is stored in different parts of the same company. We discuss these measurement challenges further in the Roadmap for Measurement section below.

Roadmap for Measurement

The discussion so far has focused on decisions and best practices for firms considering apprenticeship. In practice, firms should not make these decisions without a clear assessment of costs and benefits. In this section, we discuss how firms can quantify the costs and benefits of the major decisions we discussed in the previous section. Each decision affects the ROI in an apprenticeship program. The companies in the study weighed these questions regularly but did not always have complete information.

Above we suggested that firms will most likely start their apprenticeship based on educated guesses given available data, but it makes sense to evaluate the program more carefully once several classes of apprentices have graduated. At that point, and going forward, firms can adjust parameters such as the number of apprentices, the nature of both classroom and OJT, and so on. This evaluation is much easier if firms collect data from the beginning and have in mind clear alternative scenarios, or “counterfactuals,” that they evaluate in their analysis.

²⁰ For a fuller discussion of the benefits of managing workforce diversity, see <https://hbr.org/1996/09/making-differences-matter-a-new-paradigm-for-managing-diversity>.

The following steps will help any firm measure the return to investing in apprenticeship and then make use of what they learn along the way.

- Determine the total costs of apprenticeship and the costs of alternative hiring methods.
- Determine the measureable benefits of apprenticeship.
- Look across the company for data to measure benefits.
- Keep in mind other changes at the company and its environment that affect performance.
- Analyze and share the data across the company.
- Make improvements based on the analysis.

These points may seem obvious, but they are not necessarily easy to implement. Most of the companies in the study intuitively understood the value of many of the steps, but had only an incomplete understanding of the whole picture. Our study team began to work through this process of collecting data across the organization with two firms, Siemens and Dartmouth-Hitchcock, in order to learn more fully about their apprenticeship programs and their work processes. In the next section, we provide overviews of these companies, their approaches to apprenticeship, a discussion of the costs and benefits of their programs, and a summary of the results of our detailed economic analysis using firm data.

The level of detail in our quantitative analysis of Siemens and Dartmouth Hitchcock is intended to illustrate the power of operational data in understanding the benefits of apprenticeships; individual companies may find different levels of value in such detailed studies. This section lays out a more general approach to completing the steps identified above, using examples to illustrate how a firm's executives might think about this.

1. Determine the total costs of apprenticeship and the costs of alternative hiring methods.

For most firms, identifying costs is relatively straightforward. There are two major types of costs associated with any project: fixed and variable costs. Table 1 provides some examples of these kinds of costs, and the following sections provide more detail about how they are defined and measured.

Table 1. Costs of Apprenticeships

Fixed Costs

- Curriculum development
- Equipment purchases
- Staff time spent on setup
- Overhead and management
- Classroom space
- Recruitment

Variable Costs

- Wages and benefits of apprentices
 - Mentor time
 - Supplies and uniforms
 - Tuition, books, and classroom materials
-

Fixed Costs

Some costs remain more or less constant regardless of the number of apprentices in a program. To a large extent, these “fixed costs” represent the cost of setting up the program in the first place. Firms can develop a curriculum in-house or they can outsource this job to a local community college or workforce development organization. Modifying a pre-existing curriculum, such as an associate’s degree program, may be relatively inexpensive. Developing a new approach from scratch can be fairly costly, whether done by staff on the company payroll or by a private agent for a fee.

Purchases of equipment that can be used by all apprentices and by future classes also count as fixed costs. Hypertherm teaches students in the classroom using the same kinds of machines they will later operate on the factory floor. Dartmouth-Hitchcock provides each apprentice with a loaner laptop to use for the duration of the program and uses a projector and models of various organs in the classroom to teach students about human anatomy.

Most of the firms in the study dedicated at least one staff member to manage their programs, though some maintained larger groups of staff. CVSH employs a task force to oversee the company’s workforce development programs across the nation. These staff members manage relationships with consortia, educational institutions, community groups, government agencies, and even other groups within the company. They usually monitor overall performance of the program and manage records as well. At many firms, those staff who manage their apprenticeship programs spend the rest of their time working on other workforce management tasks or other operational tasks.

It is also important to count what economists would call “opportunity costs”—that is, the cost of using a resource for apprenticeship rather than something else it could be used to do. A major fixed cost that is also an opportunity cost is often facility space used for apprenticeship functions. Many companies repurpose conference rooms or other spaces within the existing facility to train their students. Others, like Hypertherm, realize facility costs directly when they build or retrofit spaces—in the case of the Hypertherm Technical Training Institute, at a significant cost of \$2 million.

The cost of recruiting apprentices must also be included. Recruiting costs are twofold: identifying the target population and reaching it. Job postings, participation in career fairs, presentations at local high schools or colleges, or some combination of those all entail costs. These can take the form of staff time to attend events, presentation design, materials for handouts, and so on. Many of these costs do not vary substantially with the quantity of apprentices.

Variable Costs

Some costs vary based on the number of apprentices in the program. These “variable costs” include many of the largest costs associated with apprenticeship; in particular, wages and benefits usually make up the bulk of a program’s per-apprentice costs. Most, though not all, of the firms in the study pay their apprentices for every hour they are in the program, including classroom time, as well as pay for books, supplies, and in many cases, tuition.

Because mentors take time to teach apprentices, they often work more slowly or take periods of time off from their regular work. As described in the cost section above, this represents an opportunity cost for a company—instead of mentors, who are usually experienced, senior members of the workforce, working to increase sales

or revenues, they are engaged in teaching others for some portion of their time at work. One way to measure this cost is to estimate the output of mentors, pro-rated to reflect the percentage of their work time they spend as mentors.

Adding up the Costs

Based on interviews with companies that were able to provide a fairly complete accounting of program costs, the per-apprentice costs of the firms in the study ranged from under \$25,000 to around \$250,000. While these figures are not comprehensive, they portray the large variation in per-apprentice costs faced by companies. It is essential to keep in mind, however, that all of the companies studied, whether their investments were in the tens or hundreds of thousands of dollars, believe that the payoff justified the investment.

Dartmouth Hitchcock provided the study team with a detailed breakdown of costs for running apprentice classroom training, tuition, wages of apprentices, a workforce development consultant, and two apprentice supervisors. In addition, Dartmouth-Hitchcock used long-term lease agreements on its facility to estimate the cost of classroom space. Divided across all apprentices, these costs came out to approximately \$60,000 per apprentice for the course of the one-year program.

The ultimate goal is for companies to fill skilled jobs, and apprenticeships are one way to do so. Many of the costs listed above are also incurred when the job is filled through a direct hire of an already-trained worker, the contracting of a temp worker, increasing the hours of existing staff, or some other method; this is part of the “counterfactual,” or what a firm would do instead. Firms need to compare the costs of an apprenticeship program to the costs of these alternative hiring methods when analyzing whether it makes sense to develop an apprenticeship program.

MTU America shared its recruiting costs with our study team, which we consider illustrative of the costs other small firms might bear. While advertising on the company website or on the South Carolina state employment website is free, other job sites charge approximately \$400 per ad. A ten-line newspaper ad running for two weekends costs the firm more than \$600. Hiring through a staffing agency means MTU will pay a markup of over 25 percent on the hourly rate of the employee. On average, MTU estimates that it spends \$3,000 to hire a mechanic outside of its apprenticeship program.

Hiring workers, the next step of the process, can be expensive. Almost all new workers will need some training or an adjustment period. If sufficiently skilled workers are hard to find at a reasonable wage, firms may leave positions vacant. However, the decision to leave positions vacant is not without cost—turning down work, paying overtime, or delivering product late all cost firms money.

2. Determine the measureable benefits of apprenticeship.

While the calculation of costs is fairly straightforward, determining the benefits of an apprenticeship program is often much more challenging. While many of the costs associated with running an apprenticeship program show up on the company’s balance sheet or accounts payable, the benefits of apprenticeship rarely do.

All of the organizations in the study believe that there are sizeable benefits to apprenticeship (see Table 2 for some benefits to consider), and most are helping promote apprenticeship through their participation in the DOL LEADERS program. Some benefits are realized during the apprenticeship period, while others take longer to appear. Many of the firms in the study believe that their apprentices become as productive as, or even

more productive than, employees hired off-the-street before the apprenticeship is over. As a result, these firms believe that the productive work of the apprentices more than offsets the apprentices' wages and tuition costs.

Table 2. Common Benefits of Apprenticeship

Production	Workforce	Soft Skills
<ul style="list-style-type: none"> • Output during the apprenticeship at a reduced wage • Higher post-apprenticeship productivity relative to similarly tenured employees • Reduction in mistakes or errors 	<ul style="list-style-type: none"> • Reduced turnover • Pipeline of skilled employees • Better matching of employee skills and character with employer needs and firm culture • Lower recruiting costs • Development of future managers 	<ul style="list-style-type: none"> • Employee engagement and loyalty • Greater problem-solving ability and adaptability • Reduced need for supervision

Production Metrics

During the apprenticeship, one benefit to a firm is that apprentices' labor is usually provided at a reduced wage relative to an off-the-street hire. To measure this benefit, a firm should emphasize the real metrics used to judge the success of its particular business, such as parts per minute, number of prescriptions filled, or computer coding projects successfully completed. Although performance reviews are common for measuring how an apprentice is doing, they are necessarily subjective and provide a measure of employee contribution that is often difficult to quantify.

After they graduate, apprentices may continue to have higher productivity than workers that did not receive such training. In addition, many firms cite a reduction in errors as a key benefit of apprenticeship. The likely driver of these improvements is better training in the principles behind their work. Most of the firms in the study cited classroom training in the theory of their work processes as a driver of multiple benefits. One of those is that employees who understand not just what tasks need to be performed, but also why those tasks need to be performed, are often able to diagnose potential problems before they occur, or they can quickly troubleshoot problems after they occur. A decrease in errors can reduce scrapped product due to poor quality and maintenance costs, and it can improve on-time delivery, all of which represent a benefit to the company.

Workforce Metrics

Many benefits of apprenticeship are not directly related to production outcomes, though they may improve those outcomes tangentially. Some of these benefits will be easier to measure than others, though all are important and should be considered.

Among the most-cited benefits of apprenticeship for the study firms was reduced turnover—in many cases, firms considered it even more important than increased productivity. During our site visits, apprentices described a feeling of loyalty to their hiring firm for the opportunity the apprenticeship provided them and for the relationships they developed along the way with other apprentices and their mentors. CVSH officials say that apprenticeship makes employees twice as likely to stay. BCBSSC cites an attrition rate of 4 percent for employees who graduate from their apprenticeship program, compared to an industry average of 13 percent. Dartmouth-Hitchcock went further, noting that MAs also drove a reduction in turnover for other employees; reducing physician stress and allowing them to perform work for which they were trained led to a reduction in their turnover as well.

Related to reduced turnover are the recruitment costs saved by having a pipeline of skilled employees to replace retirees or others who leave the company. For 100 years, the building trades have used an apprenticeship model to move workers from apprentice to journey worker to supervisor, providing guidance and mentorship to new apprentices at every step. BCBSSC has adopted the same model, with each level of employee responsible for teaching those at the next level below. Dr. Schneider, an auto parts manufacturer in Kentucky, believes that apprenticeship saves the firm 20 percent on recruitment costs alone, aside from the other benefits the program provides.

Many of the firms in the study used apprenticeship to find workers from a diverse pool of candidates including women, minorities, veterans, and the long-term unemployed. For many of these workers, apprenticeship represents an opportunity to gain entry to a field or industry that is otherwise difficult to enter. CVSH, in partnership with community organizations, is a strong proponent of this approach, citing both high-minded goals like corporate social responsibility and the everyday need to expand the labor force and fill positions. Apprentices can also make a firm more attractive to other skilled workers. Dartmouth-Hitchcock believes that MAs, by allowing physicians to perform more of the work for which they were trained, have improved recruitment of very highly-skilled medical professionals.

Finally, a long-term measure that firms can use, though likely only after many years of having an apprenticeship program, is the development of leaders. Many firms believed that the intensive training, immersion in company culture, and strong theoretical underpinning provided by apprenticeship were ideal for preparing future managers. While few of the programs in the study were mature enough to have strong measures of this kind of development, BCBSSC estimates that 22 percent of graduates from the apprenticeship program are currently serving in leadership roles.

Soft Skills Metrics

Other benefits that apprenticeship is likely to provide are even harder to measure. Apprentices are often grateful for the opportunity to participate in the program. As discussed above, this may show up in reduced turnover, or advancement into senior positions in the company, but it may also show up in recruitment of friends to new positions, better relationships with supervisors and colleagues, or improved customer service.

Both theoretical classroom training and hands-on cross training can give apprentices a powerful toolbox for problem-solving and adapting to unforeseen challenges. Sometimes these benefits show up in reduced errors or shorter maintenance times, but they may also result in gaining new work for a company or process improvements across the entire workforce. Apprentices are often self-starters as well, reducing workload for supervisors. Other soft skills that many programs emphasize, such as attendance, writing, and public speaking, are also key for developing future leaders.

Because they understand the principles behind their work, apprentices may be more “flexible” in several senses: they can do a greater variety of routine tasks at a point in time (leading to increased capacity utilization), they can do higher-value tasks (such as those requiring judgment or initiative), and they can facilitate innovation because they learn quickly and have problem-solving skills. The Siemens case in the next section gives an example of how to measure such benefits, which can be very large.

Adding up the Benefits

The value of apprentice output should be compared to a baseline “counterfactual” level of output for an employee that would have been hired had an apprentice not been available. Many companies in the study, including LaunchCode, Siemens, and Hypertherm, claimed that apprentices were significantly more productive than off the street employees, for the production, workforce, and soft-skill reasons listed above. Firms may not be able to find workers that meet their minimum standards. In this case, the counterfactual is turning down work or delaying completion of projects. In such cases, the margin on all of an apprentice’s output should be counted as a benefit.

For Dartmouth-Hitchcock, MAs were difficult to find in the local workforce and other staff—doctors, registered nurses, and other medical professionals—were asked to perform administrative tasks. Having these highly-paid professionals work below the highest level that they are trained and certified to perform was very expensive for Dartmouth-Hitchcock and resulted in inefficiencies or turning patients away because of the time constraints that employees faced when asked to perform additional tasks. In addition, this led to staff burnout, turnover, and additional cost. At \$250,000 just to replace a lost physician, this turnover was extremely costly—enough to pay for the hiring of several MA apprentices.²¹

Each of the metrics we discussed in this section was cited by several study firms as specifically important to them. In nearly all cases, companies measured at most one or two of the items in this list, relying on reports from management and other employees for a sense of the value of other things.

However, not every metric will matter to every firm, which is another reason why it is important to think ahead about what benefits to measure. For some companies, long term loyalty may not be a particularly important goal. If an apprentice is relatively productive during his or her training, and then chooses to leave after completing the program, a firm may have already recouped the costs of its investment. For a consortium, like Apprenticeship 2000 or the NCTAP, one of the key outcomes may be the creation of a robust local labor force with manufacturing skills that are readily transferable between member firms. Such an ecosystem benefits all partners, even if any given apprentice may not remain in a single firm for a long time.

3. Look across the company for data to measure benefits.

Once a firm has an idea of the kinds of benefits it expects to see from an apprenticeship program, it is time to collect the data that will be used to measure those benefits. It is important to begin gathering data early, even if a full evaluation of the program is difficult before several classes of apprentices have graduated. Early data collection may allow a firm to adjust parameters such as the number of apprentices and the nature of both classroom and on-the-job training if the program is not providing the desired benefits.

To measure all of these benefits, firms can collect new data or use data they already have. Firms should be creative—many already have data that they are not using, and different departments, units, or systems within a firm’s organization might be collecting data. Organizational banners are common. For example, in larger organizations, the human resources department has personnel data about wages, benefits, and turnover; the finance department has cost and revenue data that may help measure productivity; and operations has data on the real output of employees. All of these data sources can be used to take advantage of any information that the company is already collecting.

²¹ Misra-Hebert, Anita, Robert Kay, and James K. Stoller. (March/April 2004), “A Review of Physician Turnover: Rates, Causes, and Consequences,” *American Journal of Medical Quality* vol 19 no. 22, pp. 56-66. Available at: <http://aim.sagepub.com/content/19/2/56.abstract>.

However, in many firms, particularly large ones, one department may be unaware of the existence of data in other departments that is relevant to the cost-benefit analysis of apprenticeships. Existing data was likely collected for a variety of reasons, none of which may have involved measurement of the benefits of an apprenticeship program. Adapting systems to measure the contributions for these new employees may be necessary.

In practice, one challenge of data collection is the need to compare the company both before and after the implementation of an apprenticeship program. Measuring the contribution of apprentices requires knowing the baseline level of productivity, turnover, errors, or other measures in order to understand how those things changed when apprentices came onboard. To do so, firms need to have a time-series of consistent data that spans several years. For example, measuring the ROI of a four-year apprenticeship program could require data spanning a decade or more to get a clear picture of productivity before the implementation of the program, the period when apprentices are in the program, and the period after the program.

It is generally easier for firms to precisely measure performance metrics for an entire plant or other work unit rather than for individuals. For this reason, firms should first focus on these metrics and the contribution of apprentices and other workers to overall performance when trying to value apprentices' work. Once those measures are fully understood, data should be collected on individual employees to the extent possible. It is, however, very important to separate the analysis of the apprentice program from evaluation of individuals. In particular, many things early in the life of a program can go wrong (or right) that are not necessarily the fault of individual apprentices or managers.

4. Keep in mind other changes at the company and its environment that affect performance.

The importance of establishing a baseline level for each metric being measured cannot be overstated. In any company, it is rare for one program to be adopted independently of all other changes. At any given time, multiple factors will change the company's performance simultaneously: new work processes, new technologies, changes in training, and so on. Without detailed data from before and after any such change, it is difficult to understand how any given program affects overall performance.

For Dartmouth-Hitchcock and other health care providers, the last several years have been a time of great change. While Dartmouth-Hitchcock's MA apprenticeship is one factor in the company's increased service metrics over that time, the hospital also cited electronic medical records, the Affordable Care Act, and the overall aging of the population as factors changing the kinds of work Dartmouth-Hitchcock does and how it does that work. Given the firm's location in New Hampshire, even snowfall can play a factor in how many patients are willing or able to meet their doctors for a previously-scheduled appointment.

Other factors may also account for observed changes in performance. Remember that "correlation is not causation." For example, the introduction of apprentices could coincide with a general economic upturn; it is important to test whether any improved productivity is due to the apprentices or to the upturn. All of these different factors combine to affect Dartmouth-Hitchcock's performance metrics, and detailed data gathered with high frequency can make it possible to disentangle the individual effects of each factor.

5. Analyze and share the data across the company.

Performing ROI calculations in order to understand the value of an investment is nothing new for any company. Remaining profitable and successful in a competitive economy requires spending money wisely. The goal of this roadmap is to help companies think comprehensively about the costs and creatively about the

benefits of apprenticeship. Failing to do so will lead companies to underestimate both the costs and benefits, making it unlikely they can calculate the true ROI of apprenticeship programs.

The companies in the study all believed that the benefits of apprenticeship outweighed the costs, but many of them expressed a strong desire to get better numbers about their ROI for a variety of reasons: better decision making, marketing to prospective employees, convincing the board to approve funding for more apprentices, and so on. Using the roadmap here to understand the full array of costs and benefits can lead companies to the numbers they need to make a sound decision based on real data.

Once the value of apprenticeship is fully understood, firms should use that information to make better decisions. Any workforce development or talent acquisition strategy should continue to take the results into account. In addition, decisions in areas such as technology and marketing will probably be affected as well. Firms with deeply trained workers can invest in more complex equipment and may be able to target more demanding market segments, such as those requiring better customer service or faster innovation and de-bugging.

6. Make improvements based on the analysis.

As with any new business process, firms often learn as they go. In interviews, firms shared some of the lessons they learned as they have worked through implementation and administration of their apprenticeship programs. Below are some examples of tweaks firms made as a result of experience.

Mentor assignment. As noted earlier, the apprentice-mentor pairing is not always a good match, in terms of an apprentice's training needs or personality. Assessing the relationships between the apprentices and their mentors is important and firms should not be afraid to make changes to improve matches.

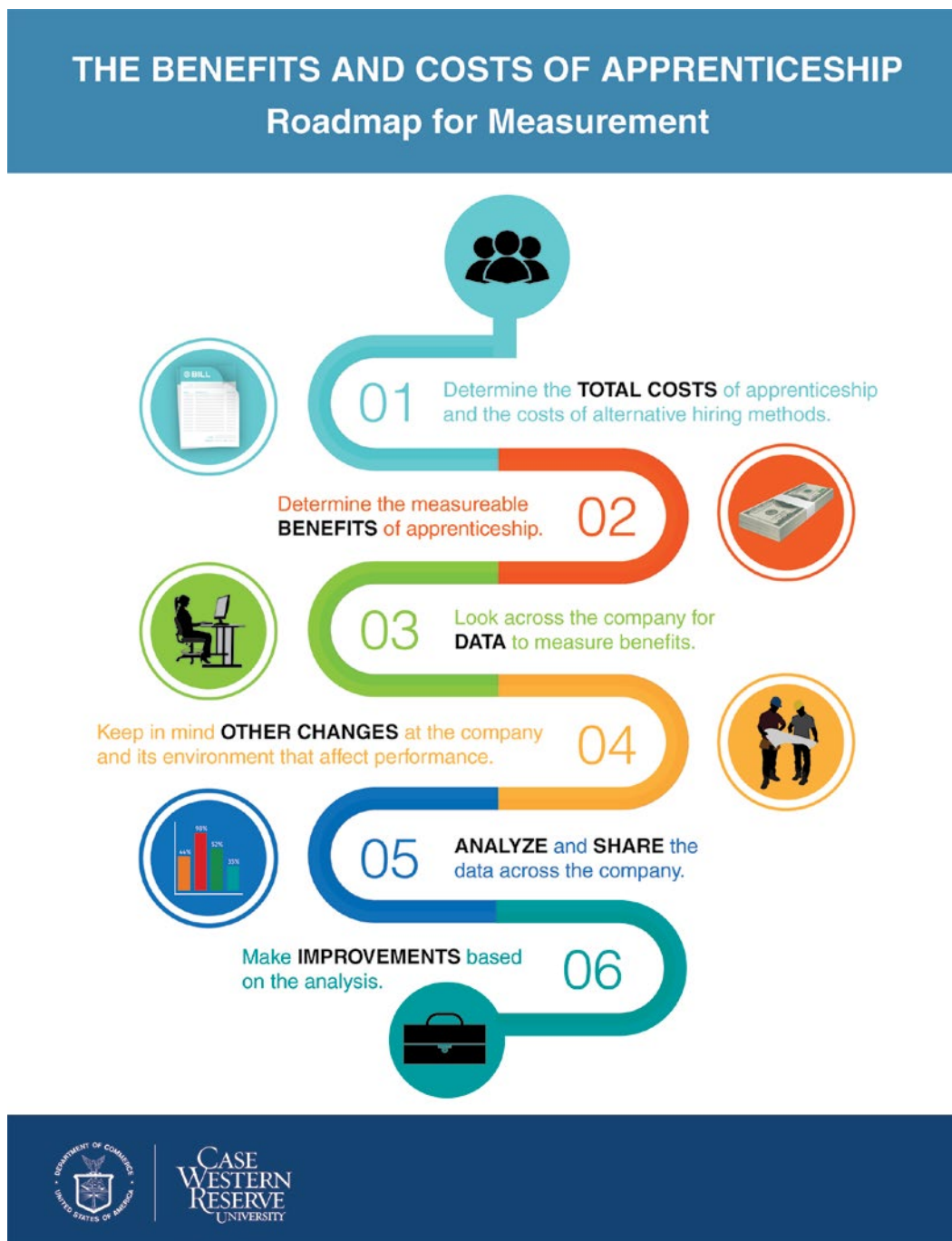
Apprentice uniforms. It may be useful to differentiate apprentices from other employees for safety or other reasons. Siemens started out by having apprentices wear different uniforms from experienced employees, in order to mark their different status. What Siemens did not foresee was that this “special” status would make it difficult for apprentices to fit in with existing employees, hindering the development of camaraderie and teamwork. Since then, Siemens has put apprentices in the same uniforms as other employees, using a badge sewn onto the uniform to identify that they are apprentices. Similarly, Dartmouth-Hitchcock uses colored stars on name badges to call out the competency level of their apprentices. These small differences in how apprentices look signify that apprentices are still in training mode but also allow them to blend in with other workers, making them feel like part of the team.

Scheduling. Dartmouth-Hitchcock experienced difficulty in the early stages of a pharmacy technician apprenticeship program because of shift schedules that were incompatible with apprentice work-life balance. Many apprentices were scheduled to work late into the night before returning early the next morning. It is difficult for any employee to perform productively on little sleep, but it may be even harder when that employee is also engaged in an intense learning process. Dartmouth-Hitchcock took this into account and fixed the scheduling process before relaunching its pharmacy technician apprenticeship program.

These are just a few examples of stories shared by companies in the study. No company got it exactly right on the first try—and what counts as “right” is a moving target. Firms' needs change over time and apprenticeship programs should change to remain useful. The companies profiled in this report provide a wealth of experience from which other firms can draw. Similarly, federal and state government partners—the Office of Apprenticeship in the DOL, in particular—can play a key role in providing advice, support, and connections.

Conclusion: Measuring the hard-to-measure.

Leaving out a hard-to-measure cost or benefit is equivalent to assuming its value is zero. For example, if one valued only the increased productivity of apprentices at Siemens, and ignored their flexibility, the case for apprenticeship would be much weaker. Where apprentices often shine, with their deep understanding of fundamental principles and hands-on knowledge, is in the unexpected or unusual. Firms may want to guess at reasonable numbers, drawing on reports such as this one to generate a range of estimates, or adopt techniques that account for variance in capacity utilization, such as the portfolio analysis described in the Siemens case in Appendix I.



Overview of Apprenticeship Programs and Intermediaries

The Decision Points and Roadmap for Measurement sections reflect the lessons learned as we studied the well-established apprenticeship programs at 11 companies and 2 intermediaries. This section provides case studies for each of the apprenticeship programs. The first two, Dartmouth-Hitchcock in Lebanon, New Hampshire, and the Siemens USA plant in Charlotte, North Carolina, are more comprehensive. We visited those two facilities to interview the senior executives overseeing the apprenticeship programs as well as several apprentices and mentors. For these two firms and the other organizations in our study, we tried to gain a thorough understanding of the

- background
- motivation
- recruitment process
- program design
- costs and benefits associated with each of those programs

Subsequent to our visits, we reached agreements with Dartmouth-Hitchcock and Siemens USA to gain access to more detailed production and cost data, which has allowed us to statistically assess some of the costs and benefits for their apprenticeship programs. The remaining 11 case studies do not contain similarly detailed data but do list enough to underscore the surprising range of costs and benefits for each apprenticeship program—with all companies viewing the value to their companies of their apprenticeship programs as being unequivocally positive.

The following organizations are profiled here:

- Dartmouth-Hitchcock
- Siemens USA
- Blue Cross Blue Shield of South Carolina
- CVS Health
- Dr. Schneider Automotive Systems
- Hyperthem
- LaunchCode
- Max Daetwyler Industries and Apprenticeship 2000
- MTU America
- North America's Building Trades Unions
- Oberg Industries
- United Auto Workers-Ford Motor Company
- Vermont HITEC

Dartmouth-Hitchcock

Location: Lebanon, New Hampshire

Occupations of apprentices:

- Medical assistant
- Pharmacy technician
- Patient registration representative
- Medical coder
- Phlebotomist

Company Web Address: <http://www.dartmouth-hitchcock.org/>

Background²²

Dartmouth-Hitchcock is a nonprofit academic health system that serves a population of 1.9 million in New England. Dartmouth-Hitchcock provides access to more than 1,000 primary care doctors and specialists in almost every area of medicine, delivering care in Lebanon, NH at its flagship, Dartmouth-Hitchcock Medical Center; the Norris Cotton Cancer Center, one of only 45 Comprehensive Cancer Centers in the nation; the Children’s Hospital at Dartmouth-Hitchcock; affiliate hospitals in Lebanon, Keene, and New London, New Hampshire, and Windsor, Vermont; through the Visiting Nurse and Hospice for Vermont and New Hampshire; and at 24 ambulatory care clinics across New Hampshire and Vermont. In early 2014, Dartmouth-Hitchcock began an apprenticeship program to train medical assistants (MAs) for its new primary care clinic located on Heater Road in Lebanon.

At Dartmouth-Hitchcock primary care clinics, MAs help doctors, physician assistants, registered nurses, and other medical providers. They are responsible for numerous tasks including:

- Walking patients from the waiting room to the exam room and checking height, weight, and blood pressure.
- Reviewing medical history forms and identifying the reason for the visit.
- Performing basic medical procedures such as drawing blood and administering vaccines and immunizations.
- Handling basic incoming patient inquiries that do not involve an assessment of symptoms.
- Calling patients to remind them of upcoming visits or to schedule visits for check-ups or regular preventive care.
- Preparing prescription refills for physician review and doing other paperwork.

In 2012, the new primary care clinic on Heater Road combined internists and pediatricians formerly housed in the main Dartmouth-Hitchcock Medical Center building with family physicians from another clinic location due to the lack of space for expansion in the former facilities. During the transition to the new facility, staff were also transitioning to a new electronic medical records system and to a team-based care model, described in more detail below. In addition to these institutional changes, Dartmouth-Hitchcock was having trouble recruiting qualified MAs to work at the Heater Road clinic. Existing MA training programs in the local area produced

²² For more information on Dartmouth-Hitchcock’s apprenticeship programs, see: <http://careers.dartmouth-hitchcock.org/resources/workforce-development.html>.

only a small number of new graduates each year and experienced applicants were rare. Dartmouth-Hitchcock believed that a pipeline of qualified, trained MAs would be essential to its success in navigating all the changes at the new clinic. Dartmouth-Hitchcock created the apprenticeship program to address this talent gap and to fill the clinics' emerging workforce needs. Without this program, Dartmouth-Hitchcock believes it would have been unable to hire sufficient MAs to complete the transitions.

Motivation

Since 2013, and coincident with the use of electronic medical records, Dartmouth-Hitchcock has transitioned to a team-based care model that includes MAs as an integral part of patient care. Under this model, the clinic uses balanced teams of care workers. Teams are split into three smaller “teamlets,” each of which has two providers—for example, one medical doctor and one physician assistant—who are assigned two MAs. The entire team shares registered nurses. The team-based care model allows each staff member to specialize



in the level of care that he or she is trained to provide. Dartmouth-Hitchcock's goal is to have each team member “working to the top of their license.” This means that doctors, who are trained and licensed to provide specialized medical care do not spend their time walking patients to an exam room or responding to patient inquiries for basic, non-urgent questions—tasks that can be handled by an MA—but can instead focus on delivering the care only a physician is qualified to provide. Additionally, when patients schedule visits and go to the clinic for appointments, they typically interact with a designated teamlet of providers, MAs, and registered nurses, which allows for more personalized care.

To effectively deliver this team-based care model, Dartmouth-Hitchcock required more MAs. While Dartmouth-Hitchcock has a state-wide footprint, the Heater road facility serves a primarily rural community where there was a significant shortage of skilled MAs in the local commuting area. There are few local colleges with MA programs, and many graduates choose to move away to larger cities after graduation. Experienced licensed MA candidates from more populated areas face expensive relocation or an hour-plus commute for a position paying \$13 to \$20 per hour, and similar positions exist closer to home for them. Dartmouth-Hitchcock reassessed its pay practices for this role, but even at a slightly higher wage, candidates to fill empty MA positions were hard to find.

Prior to starting the apprentice program, Dartmouth-Hitchcock was operating with a four-to-one provider-to-MA ratio at the Heater Road facility. At this ratio, patients were being turned away because providers were frequently required to cover basic support tasks such as walking patients to exam rooms and checking their vital signs. Having providers or nurses spend time on these and other support tasks detracted from the time they had available to see patients and resulted in Dartmouth-Hitchcock having to pay these providers top dollar for time not spent examining patients, evaluating symptoms, and diagnosing illnesses.

In addition to patient support, MAs assist providers in other ways. Before MA apprentices came to Heater Road, nurses were providing prescription support, which took an average of two hours a day from time they

could have spent with patients. Additionally, many providers and nurses were frustrated to be covering these tasks at the expense of doing “top of license” work, resulting in higher turnover in these positions. MAs free up the nurses’ time by preliminarily reviewing requests for as many as 300 prescription renewals a week and then preparing the requests for physician review and approval. MAs also assist with scheduling, helping the clinic to use capacity more efficiently. This shift in focus means that patients are able to see providers within a few days, as opposed to the longer wait times experienced under the old system.

To summarize, the MA apprenticeship program had the following impacts for the Heater Road primary care clinic: Reduced costs, due to reduced overtime of all providers and lower wages of MAs.

- Enabled the team-based care model to succeed by providing the a pool of qualified MA candidates.
- Increased provider satisfaction due to increased time spent delivering care they were trained to do.
- Increased patient satisfaction, because of reduced wait time to obtain an appointment.

Recruitment

The apprenticeship program was attractive to Dartmouth-Hitchcock because it allowed for identifying candidates who demonstrated the right characteristics for patient care and to provide them with the specific technical skills needed to perform the role of an MA. The ideal candidate is eager and ready for change, can follow directions, and has good communication skills and an attention to detail, cares about people and customer service, and wants to make a difference. No prior health care experience is needed; most MA apprentices have come from non-medical fields.

To find candidates, Dartmouth-Hitchcock launched an advertising campaign that targeted local residents—specifically, underemployed and recently unemployed workers, recent high school graduates, veterans, and individuals looking to return to work after a gap in employment. The organization believed that there were people in the area who would be eager for the opportunity. A demographic analysis of participants shows that the majority of people accepted into the program were in the labor market prior to starting the program but were either unemployed (39 percent) or underemployed (54 percent). About half, 54 percent, enter the program already holding an academic degree beyond a high school diploma, and 27 percent were over the age of 40.

Dartmouth-Hitchcock advertises the program using print and radio advertisements, social media, and some more creative grass roots approaches including coupon mailers, ads on the backs of unemployment checks, and posters in local supermarkets and laundromats. Over time, word-of-mouth has also become an important outreach tool as many apprentices in subsequent programs are the friends and family of prior apprentices and other Dartmouth-Hitchcock employees.

The applicants are put through a rigorous two-week selection process. This includes an orientation where candidates are expected to show up on time, bring multiple copies of their resume, and submit a detailed application online. Dartmouth-Hitchcock staff note applicants’ ability to follow these directions. Candidates then go through two rounds of interviews and are tested for basic math, customer service, and reading comprehension skills. Dartmouth-Hitchcock clinicians, human resources staff, and classroom instructors interview candidates noting how they interact with others and how they conduct themselves during the process. Dartmouth-Hitchcock offers apprenticeships only to candidates that demonstrate they can make it through the demanding classroom training portion of the program and who are committed to the care of others. A typical selection process starts with an applicant pool of over 150 candidates and concludes with an MA apprenticeship class of 15 to 20. The pool of candidates is sometimes limited by the fact that participants are not paid during the 11-week training course, as described below; in some cases, grant funding was found to cover students’ living costs.

Program Details

Dartmouth-Hitchcock partners with Vermont HITEC (now known as The Institute for American Apprenticeship) for the selection and classroom portion of the apprenticeship training. As part of a four-year contract, Vermont HITEC staff worked side-by-side with the Dartmouth-Hitchcock team to understand both the core skills needed to be an MA and how to best teach those skills to apprentices in the Dartmouth-Hitchcock environment. Vermont HITEC accomplished this by going into the clinic and reverse engineering the MA role. The end result was a comprehensive training course and competency-based apprenticeship curriculum. Vermont HITEC provides Dartmouth-Hitchcock with classroom instructors and the training materials. In 2015, Dartmouth-Hitchcock and Vermont HITEC formed a partnership with Burlington College to award up to 68 hours of academic credit (45 hours of which is applicable toward an associate's degree, representing 75 percent of the required credit hours) to apprentices upon completion of the program.

All apprentices attend an 11-week pre-employment classroom training program.²³ During this training, the apprentices are considered students of Vermont HITEC, not employees of Dartmouth-Hitchcock, and they are not paid. A combination of federal and state grants, charitable donations, and sometimes Dartmouth-Hitchcock sponsorship, covers the tuition cost of \$10,000 for each apprentice. Each apprentice receives two uniforms and textbooks at no cost, which are theirs to keep. Loaner laptops are also provided. The classroom training is intense—it takes place for eight hours a day, five days a week, and apprentices are expected to complete three to four hours of homework per night. The classroom instruction is intended to reinforce the material and instructors expect the apprentices to come to the lesson ready to demonstrate what they've learned on their own. The training is a combination of verbal exercises, quizzes, lectures, and practical hands-on training. The hands-on training takes the form of injecting oranges to practice administering vaccines, modeling hearts out of clay, or practicing taking blood pressures on other apprentices, for example.



After completing three weeks of classroom training, the apprentices begin clinical shadowing of other MAs at Dartmouth-Hitchcock and observe the tasks they are learning in the classroom. During the shadowing, apprentices do not assist with any tasks on patients. At the end of the 11 weeks in the classroom, the apprentices take the Certified Clinical Medical Assistant (CCMA) written exam. If successful, they begin the OJT portion of their apprenticeship program and become full-time Dartmouth-Hitchcock employees. Currently, Dartmouth-Hitchcock MA apprentices have a 100 percent CCMA exam pass rate. Dartmouth-Hitchcock pays apprentices a starting wage of \$14.50 per hour and provides full benefits. Pay raises are awarded at six months and then again about six months later contingent upon demonstration of clearly articulated competencies and completion of the program.

²³ Originally the classroom training was offered over 10 weeks, but Dartmouth-Hitchcock instituted a “reading week” in the middle of the training that allows the apprentices to catch up and meet with instructors to reinforce any concepts they are struggling with.

As apprentices, the MAs typically spend one year in this on-the-job training before taking the Registered Medical Apprentice (RMA) exam and graduating. As noted earlier, the typical MA certification program lasts two years, so apprenticeship is a way to fast-track employees into the occupation.

As noted, the MA program was initially motivated by a shortage of MA candidates in the Lebanon area. Until recently, all MA apprentices have been placed in primary care facilities around this area. However, starting with the fourth and fifth cohorts, who are currently in training, some apprentices will be placed in specialty practices and in facilities in other parts of the state. When MAs transfer to a specialty group, they can build on the skills they have already attained in primary care. Creating career ladders like these can help keep MAs in the Dartmouth-Hitchcock system, as many of the apprentices see the MA program as just a step in their career. It is the hope of Dartmouth-Hitchcock leadership that MAs will continue to grow and develop with their organization through their careers. Employees are offered tuition reimbursement for further education and there are institutional scholarships and partnerships with local colleges should an MA want to pursue a higher degree, such as a nursing degree. Dartmouth-Hitchcock sees registered apprenticeship as a way to grow local residents in health care careers and to build a locally sustainable workforce.

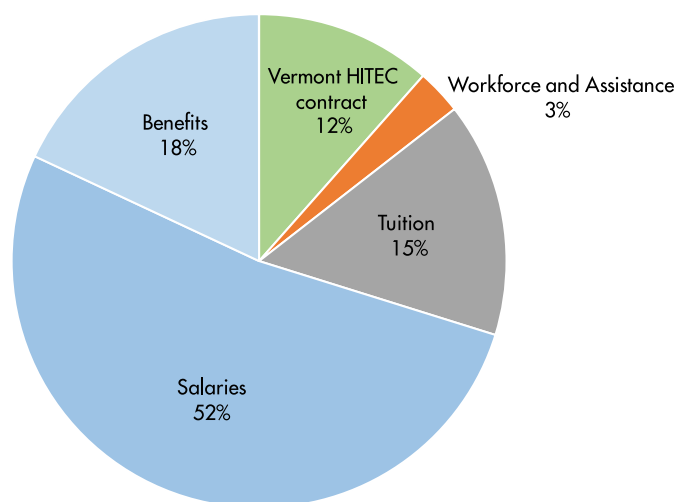
Costs and Benefits

Dartmouth-Hitchcock shared meticulous cost data associated with the first three cohorts of its apprenticeship program. For these cohorts, the average cost per apprentice was about \$59,700, with 70 percent representing apprentice wages and benefits that would also be paid to an experienced, non-apprentice hire in salary and benefits. Tuition for the classroom training was the second largest cost, at 15 percent.

The contract to Vermont HITEC represented 12 percent of the program costs; the contract covers numerous expenses including curriculum development, one instructor and one project leader per program, recruitment, classroom supplies and uniforms, and some overhead and management. Dartmouth-Hitchcock’s own overhead took 2 percent of the apprenticeship budget, while direct mentor costs were 1 percent (see Figure 1).

The \$59,700 is about \$22,200 more expensive than hiring fully trained MAs.²⁴ This difference represents the training, overhead, and mentorship costs of the apprenticeship, offset to some degree by the fact that apprentices earn less than fully trained workers. It is important to note, though, that these workers were not actually available in the local market to be hired at Heater Road.

Figure 1 : Distribution of first year apprenticeship costs (cohorts 1-3)



Source: ESA calculations using data from Dartmouth-Hitchcock Medical Center

²⁴ The salary for an experienced MA is slightly higher than the salary of an apprentice; however, these positions frequently go unfilled even at \$18 per hour as the local labor market lacks a cadre of qualified MA candidates to fill the vacancies.

Dartmouth-Hitchcock was able to save about \$12,800 per apprentice because of grant funding and also paid a lower hourly wage rate for apprentices than for experienced workers. These grants reimbursed approximately 13 percent of wages and 96 percent of tuition to eligible apprentices. Adjusting for the grants, the per-apprentice cost of the apprenticeship program was \$47,000, approximately \$10,000 more than hiring fully-trained MAs.

With data provided by Dartmouth-Hitchcock, we are able to estimate the following benefits from apprenticeship:

1. **Reduced overtime costs.** Because the local labor market was unable to supply MAs before the apprenticeship program started, Dartmouth-Hitchcock had to resort to a more expensive alternative: paying providers overtime to carry out some MA tasks. Before the apprenticeship program began, Dartmouth-Hitchcock estimates it was paying about \$36 an hour in overtime or more expensive labor costs. Once it began its apprenticeship program, the company was able to fill MA vacancies, and even during the first cohort of apprentices, Dartmouth-Hitchcock was able to reduce its overtime charges significantly. We assumed that one MA hour saved \$24 per hour in overtime charges. (We could think of this as one MA hour at straight time offsetting one overtime hour of a licensed nursing assistant or other narrowly trained person, or a portion of an hour of an MD or RN, who are paid far more.)
2. **Reduced physician turnover.** The apprenticeship program allowed Dartmouth-Hitchcock to implement its team-based care model. According to Dartmouth-Hitchcock, the new care model improved Dartmouth-Hitchcock's ability to schedule needed procedures and drugs. Achieving balanced MA-provider ratios helped with recruitment and retention of providers; with nine new providers were hired and none have left for work-related reasons since the MA program started. The cost of replacing a physician is \$250,000, or roughly the cost of training four apprentices, so even a small reduction in turnover brought notable cost savings to Dartmouth-Hitchcock (about \$2000 per MA per year).²⁵
3. **Increased primary care appointments booked.** Following the implementation of the third apprentice cohort, booked hours at Heater Road and general internal medicine were 760 hours per month higher than before the team-based care program began (see Figure 2).²⁶ Many factors besides increased use of MAs could account for these results, however. To try to isolate the impact of the new MA program, we compared these changes to those at DHMCs Manchester, NH facility. No major changes in work organization occurred in this facility; before, during and after the period when Lebanon was implementing its apprenticeship program, Manchester continued to hire skilled MAs directly from the local labor market. The Manchester facility was able to do this because of its location in an urban center, with access to community colleges offering this training.

Using a statistical technique called “difference in differences estimation”, we found that compared to the Manchester facility booked hours increased 318 hours per month after the third cohort of MA apprentices was in place. Assuming reimbursement of \$100 per hour, the growth in revenue was \$31,800 per month.^{27,28}

²⁵ Misra-Hebert, Anita, Robert Kay, and James K. Stoller. (March/April 2004), “A Review of Physician Turnover: Rates, Causes, and Consequences,” *American Journal of Medical Quality* vol. 19 no. 22, pp. 56-66. Available at: <http://ajm.sagepub.com/content/19/2/56.abstract>.

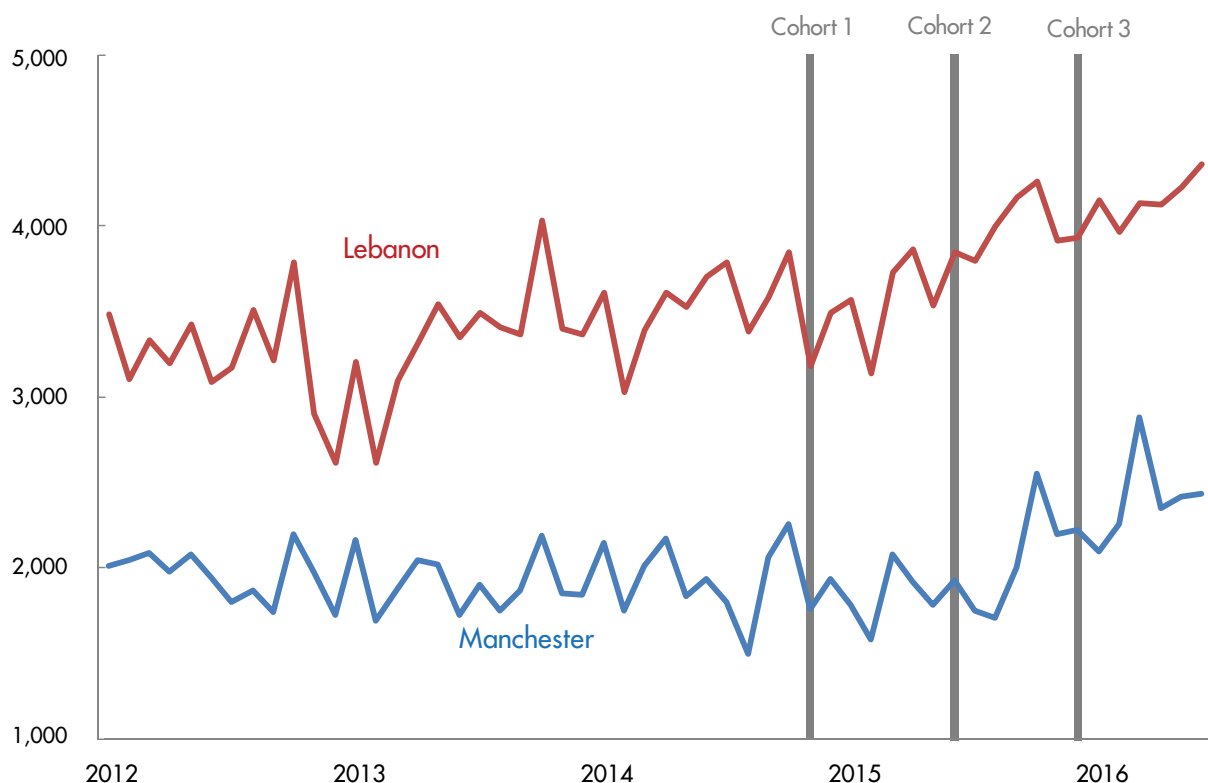
²⁶ Booked hours at the Manchester facility were 443 hours per month higher comparing the same time periods.

²⁷ 55 of the 58 trained MAs were placed in primary care, or general internal medicine locations.

²⁸ \$100 is about equal to \$99.18 median Medicare reimbursement for an office consultation in 2015. See the Centers for Medicare and Medicaid Studies Physician Fee Schedule at <https://www.cms.gov/medicare/medicare-fee-for-service-payment/physicianfeesched/>.

Put another way, Dartmouth-Hitchcock was able to achieve a \$7,000 per apprentice increase in annual revenue from booked hours because it brought on 55 MAs. (To the extent that hours in Lebanon would have continued to increase relative to Manchester, we are overestimating the increase in booked hours that are due to the apprenticeship program. To the extent that the use of overtime in Lebanon was unsustainable and would not have allowed any further increase in booked hours, we are underestimating the increase in booked hours that are due to the apprenticeship program. See Appendix I for more details.)

Figure 2. Booked hours per month



Source: ESA calculations using data from Dartmouth-Hitchcock Medical Center

Overall, we find the benefits per MA apprentice graduate are \$48,000 in reduced overtime and \$7,000 in increased revenue from additional booked hours as of the third cohort for a total of \$55,000. Given that training apprentices costs only \$22,200 each (and only \$9,400 when including grant funding), the program pays for itself, even after accounting for wage and benefit costs. This calculation does not include other (but more difficult to quantify) benefits, such as improved provider satisfaction, improved patient satisfaction (as the result of swifter appointment scheduling and high levels of engaged care), and other financial and quality benefits that are generated by moving to team based care.

If we look at the internal return on investment of using apprentice MAs versus provider overtime and assume that turnover of providers decreased by just one quit over a four-year period, the ROI of hiring apprentices relative to using overtime is at least 40 percent. This figure assumes no grant funding. In short, the case for Dartmouth-Hitchcock's apprenticeship program is compelling.

Given the high degree of institutional change and the number of newly trained MAs, maintaining quality of care could become difficult. Although there is limited data to date, there is evidence that quality of care was not adversely affected and may be improving.

One example of quality maintenance is preventive care completions, such as for colonoscopies and flu vaccinations. MA apprentices are tasked with reaching out directly to patients to schedule these appointments, and completion of these preventive screenings are higher in Lebanon than Manchester, NH, where there was not an apprenticeship program in the time frame of this study. In short, the use of apprentices did not worsen the outcomes in Lebanon relative to Manchester. The newly trained MA apprentices were as productive as the experienced ones that were hired in Manchester.

These results reflect the clinical environment in the first 24 months of the apprenticeship program. As Dartmouth-Hitchcock MA apprentices gain experience and can step into mentor roles for new apprentices, the clinic anticipates efficiency and satisfaction will continue to increase. Dartmouth-Hitchcock is looking for ways to grow and expand the MA apprentice program into its other clinics and its affiliate hospitals as a part of a longer term strategy to build and sustain a local New Hampshire workforce.

Siemens USA

Background

Siemens USA is a U.S. subsidiary of Siemens AG, a major multinational corporation founded in 1847 and headquartered in Germany. Focused on the areas of electrification, automation and digitalization, Siemens' portfolio includes fuel-efficient gas turbines, high-speed electric locomotives, digital grids, wind turbines, optimized drive technologies for manufacturers, resource-saving building automation and, energy-efficient health care equipment. Siemens USA employs approximately 50,000 workers across all 50 states and Puerto Rico and had revenue of \$22.4 billion in fiscal year 2015.

On over a million square feet of advanced manufacturing space, Siemens' Charlotte employees produce highly-customized turbines and generators that require precision down to the micron. These massive turbines and generators are used for power generation across the United States and around the world.

Motivation

Apprenticeship programs have long been important to the company's workforce in Germany and have been revived as part of Siemens' U.S. training operations.²⁹ Unable to find enough qualified machinists in the Charlotte region when the company expanded its energy hub there, Siemens began its apprenticeship initiative in 2011 as a member of North Carolina's Apprenticeship 2000 consortium.³⁰ In 2014, Siemens began a standalone apprenticeship program, which now covers three trades: CNC machinist, mechatronics electrician, and mechatronics technician.

The new program allows the company to recruit high-potential high school students and "grow" them into skilled employees in-house, instilling company values from the start. Apprenticeship graduates understand the principles behind what they are doing.

Since establishing its program in Charlotte, Siemens has created similar programs elsewhere in the United States. For example, it has a machinist program at its electric component manufacturing plant in Fort Payne, Alabama, and a testing technology program at its drives manufacturing plant near Atlanta.

Recruiting

Siemens treats recruiting as a collaborative process with multiple local educational institutions. Beginning each fall, Siemens in Charlotte recruits youth apprentices primarily from local high schools in Mecklenburg County, counties in South Carolina, and Central Piedmont Community College (CPCC is a fellow inaugural member of Apprenticeship 2000). The company emphasizes building relationships with career development counselors, who are able to select a pool of students from their schools as candidates for the program. Siemens employees who graduated from the apprenticeship program are also deployed as ambassadors for the program in local schools. Basic requirements include a minimum 2.5 GPA; passing a CPCC placement test (if home school student or veteran); completion of Algebra 1, Algebra 2, and Geometry; and no more than 5 absences from school per year.

²⁹ Siemens now has apprenticeship programs in 19 countries. For more information, see: http://www.siemens.com/jobs/en/level-of-experience/school_leavers.htm.

³⁰ While no longer a full member of the group, Siemens remains an associate member, attending meetings and sharing best practices with other North Carolina firms.

Once a pool is gathered, officials from Siemens give a presentation to the candidates describing the program and the application and selection process. The company then invites candidates to an open house at the Charlotte plant in January, during which they have an opportunity to tour the plant with a parent or guardian.

Siemens uses a variety of pre-screening methods, such as placement exam scores from CPCC, Accuplacer test scores, transcripts, and letters of recommendation, to select participants for an orientation that lasts four nights in March. During the orientation, candidates learn about workplace safety, measurement and conversion, light machining, and the basics of reading engineering drawings. At the same time, Siemens administers a custom-designed test in addition to a standard mechanical aptitude test to assess the participants' abilities and work ethic.

After the orientation, Siemens invites strong candidates to a paid 6-week summer internship, in which Siemens can make a final evaluation. The interns take two courses at CPCC—industrial safety and introduction to engineering—as well as spend time on the shop floor. They are assessed for performance, attitude, skillset, and engagement, and are given a final project to present to senior management as a capstone. At the end of the internship, Siemens makes offers to successful interns to enter into the apprenticeship program based on business needs. New apprentices begin in August, coinciding with the academic calendar at CPCC.



In recent years, the company has invited about 80 students to the January Open House, selects 8 to 10 for the summer internship, and ultimately offers an apprenticeship to up to 7 students. Because of the high wages (\$23 per hour and benefits in the third and fourth years) and excellent training that Siemens provides, it is able to recruit students with high potential and greater inclination for classroom study than is typical for off-the-street hires.

Program Details

The apprentices must complete highly technical training in the classroom and on the job to work on the Siemens factory floor. Journeypersons and apprentices with whom we spoke at the plant explained that their goal was to be more than a “machine operator,” someone who essentially pushes a button and lets the machine do the work. Rather, they wanted to become a “machinist,” someone who can program the computer to machine a part, identify and correct coding errors, and know exactly how the code will translate into production on the manufactured part. Because of the massive size and cost of the parts they are manufacturing, a mistake could cost tens of thousands of dollars. In this precision manufacturing environment, there is no room for error.

Over a span of four years, Siemens' apprentices spend 1,600 hours in the classroom and another 6,400 hours in OJT in the plant. While Siemens is still an associate member of the Apprenticeship 2000 consortium, it has launched its own program, and continues to partner with CPCC for the classroom portion of the

apprenticeship training. As in the Apprenticeship 2000 program, apprentices earn their journeyperson's certificate from the North Carolina Department of Commerce, as well as an associate's degree in computer integrated machining or mechatronics from CPCC. The graduates of the Apprenticeship program are placed into positions at Siemens as they become available to.



The first class of Siemens' apprentices graduated in August 2015, with the second finishing in December of the same year. (Because Siemens puts youth and veteran apprentices in different cohorts, there may be multiple graduations in the same year.) There are currently 15 apprentices at Siemens in Charlotte and 11 graduates including 3 military veterans; several apprentice graduates are pursuing engineering degrees (at Siemens' expense) while working full-time.

All Siemens apprentices are enrolled in a five-semester program at CPCC's main campus located in downtown Charlotte in either computer integrated machining or mechatronics, resulting in an associate's degree. The academic curriculum is stretched out over three and a half years to allow for OJT at the Siemens plant. In order to minimize travel and maximize floor time, apprentices typically attend all classes one or two days per week and spend the remaining time in their working week at the plant.

Siemens uses a time-based model rather than a competency-based model, which it prefers for a few reasons. Because the program is tied to an academic degree program, using a time-based model allows apprentices to move through the academic program on CPCC's calendar. In addition, because many of Siemens' apprentices are young and may still even be in high school, a time-based model allows them to mature personally and professionally. Finally, Siemens sees benefits from using a cohort model in which each class of apprentices learns and works together, building a support structure for each other and serving as quasi-mentors to younger cohorts.

One unique topic that Siemens highlighted was employee dress. Apprentices wear the same uniforms as all other employees, but with a patch to indicate their training status. In the past, apprentices dressed differently, but Siemens found that it hindered integration with regular employees.

Costs and Benefits

Siemens' estimates its typical per-apprentice cost at \$187,000, with apprentice and mentor wages and costs representing about 96 percent of program costs. Tuition at CPCC costs just \$76 per credit hour for North Carolina residents; as a result, tuition costs per apprentice are about \$5,500; books cost an additional \$4,800. However, in the absence of apprentices, Siemens would still need to fill the position for which apprentices are trained. A low-experience worker hired directly from the labor market is the best point of comparison for a graduate of the apprenticeship program, and our analysis assumes that the starting salary and benefits for that kind of worker would be \$56,000. The net cost of onboarding an apprentice graduate is then \$131,000.

Based on our analysis of data and discussions with company officials, we identified four potential measurable benefits from its apprenticeship program.

1. Better adherence to planned production times.
2. Higher capacity, because apprentice graduates are even more productive than pre-trained off-the-street hires.
3. Filling a job that would otherwise go unfilled, in which case the entire margin on the apprentice's product counts as a benefit, because that product would not otherwise have been produced.
4. Increased capacity to do a variety of jobs, such as machining new generators and repairing old ones.

As detailed in Appendix I, we find that, compared to hiring a machinist off the street, apprentices are less likely to be late and more productive than a pre-trained hire. The costs and benefits of apprenticeship are measured using the “internal rate of return,” or the rate of return generated by investing in the apprentice's training upfront. These direct benefits yield an internal rate of return of about 8 percent over hiring a low-experience labor.

We also explored the benefits of apprentice flexibility and found a much larger return. In fact, we found that the program would easily pay for itself by the end of a journey person's first year. Compared to off-the-street hires or even other Siemens employees with much greater experience, apprentice graduates are all cross-trained on a variety of tasks and can be assigned to almost any operation. In particular, two kinds of flexibility are important at Siemens:

- a. the ability to work on almost any machine if demand for operations requiring that machine is higher than usual or if the person who usually runs that machine is on leave, and
- b. the ability to repair existing generators and turbines (in addition to building new ones).

Both of these types of value are potentially quite large. The data collected by Siemens, however, makes estimation of the first type of benefit difficult, so the study team focused on the value of the second type of flexibility. Because apprentice graduates have a strong grasp of the principles of their work—as well as the ability to read blueprints and program machines—they are particularly well suited for tasks involving judgment, such as repair work. The plant seeks work servicing pre-existing generators and turbines when it has excess capacity.

The plant would like to ensure that it has enough capacity to complete all orders for new generators in a reasonable (and contractually specified) time. However, demand fluctuates. Data we received from Siemens suggests that given the value of generators and fluctuations in demand, the plant on average should maintain about 20 percent flexible capacity.³¹ If the plant has apprentice graduates, and if demand for repair work is sufficient to fill the 20 percent flexible capacity, it can use this downtime to perform repair work. We make the strong assumption that workers hired off the street cannot perform this work, which may allow us to capture the value of the first type of apprentice flexibility as well. In this scenario, the internal rate of return easily reaches 50 percent and can be higher. Although these assumptions are a bit crude, they capture a robust finding: since apprentice graduates have the necessary skills and judgment to take on complex work and fill slack time in the plant by doing this type of repair work, Siemens can rapidly recoup the costs of training—likely within the first year of apprentice graduates working full-time.

³¹ For methodology to determine optimal operation when a plant has the ability to make both a time-sensitive product with fluctuating demand and a time insensitive product, see “Options-Based Costing and the Volatility Portfolio,” Suzanne de Treville, Kyle Cattani, Lauri Saarinen, University of Lausanne Working Paper, 2016.

To the extent that the local labor market is unable to supply off-the-street hires, the alternative to apprenticeship is likely to be leaving a position unfilled and turning down work—either by declining contracts or extending deadlines on all work to create schedule slack, which have the same financial impact in the long run. In this case, the benefit of having an apprentice graduate is the entire margin of that employee's work. Given the margins on Siemens' products—large, complicated, advanced energy-producing machinery—the program would easily pay for itself by the end of an apprentice graduate's first year of full-time work.

Finally, these estimates are necessarily conservative because they exclude a variety of potential benefits, such as improved quality control, lower turnover, and the creation of a durable pipeline of skilled labor and management.

Blue Cross Blue Shield of South Carolina

Location: Columbia, South Carolina

Occupations of apprentices:

- Information security administrator
- Information security risk analyst
- Database programmer
- Computer programmer
- System support technician
- Server technician
- Network technician

Company Web Address: <https://www.southcarolinablues.com/web/public/sc/>

Background³²

Blue Cross Blue Shield of South Carolina (BCBSSC), founded in 1946, is the only South Carolina-based health insurance carrier and one of the state's largest employers. BCBSSC offers health insurance to nearly a million South Carolinians in all market segments, including to individuals, families, businesses, and people with Medicare or Medicaid. BCBSSC began running its Entry Level Training Program (ELTP) in 1997. While the ELTP has long followed a basic earn-and-learn model that effectively makes it an apprenticeship, BCBSSC did not register the program with DOL until 2009. Registration allowed the company to take advantage of South Carolina's \$1,000 per-apprentice tax credit.

Motivation

ELTP is a program designed to bring in new talent for BCBSSC's 2,000-person IT division. Not only is BCBSSC the largest health insurance provider in South Carolina, it also is responsible for processing a significant portion of the nation's overall health care spending. As a result, BCBSSC employs more IT professionals than any other firm in Columbia. These IT workers are responsible for server management, application development, network management, telecommunications, and systems support.

In total, 528 people have participated in the ELTP since 1997, with 300 still active employees of BCBSSC. While ELTP is the primary method used for filling positions with employees who have no prior work experience in the IT field, BCBSSC relies on traditional hiring practices to bring on experienced candidates in more senior roles. Between 2011 and 2015, around 12 percent of all new hires at BCBSSC were brought on through the ELTP, accounting for over 90 percent of all entry-level hires in the period. ELTP hires jumped to 21 percent in 2016 as the company became more aggressive in recruiting to replace their retiring workforce over the next 5 to 10 years.

³² For more information on BCBSSC apprenticeship programs, see: <http://www.apprenticeshipcarolina.com/testimonials/bluecross-blueshield-it-apprentice-program.html>.

Recruiting

Unlike the other apprenticeships profiled in this study, 80 percent of BCBSSC's apprentices are new college graduates, mainly with computer-science degrees. Recruiting for the ELTP differs slightly from most other firms in this study because it recruits heavily at college career fairs and also uses social media, student information sessions, and networking events. As a result, ELTP participants tend to be relatively highly educated and slightly older than apprentices at other companies in this study.

ELTP's sophisticated process for setting its recruitment goals provides a model for any firm thinking about how many apprentices it will need. Assistant Vice Presidents (AVPs) use internal modeling to identify current and future gaps in their groups. Retirement is the main driver of those needs, with demands for services and active contracts also playing a role. AVPs submit their staffing requests to senior management for approval, after which they are added to next year's budget. Before any recruiting takes place, BCBSSC has already built each individual apprentice into its planned expenditures.

Program Details

The four-track ELTP curriculum is primarily technical training. Two tracks—infrastructure and systems support—are provided offsite at Midlands Technical College; the remaining two—application development in either the mainframe or non-mainframe environment—are provided onsite at BCBSSC. The classroom training portion of these tracks lasts 16 to 20 weeks, depending on the track. Two of the four tracks—infrastructure and systems support—result in three certifications from the Computing Technology Industry Association (CompTIA), a major non-profit IT industry association. Across all four tracks, the ELTP provides 169 distinct courses or training events, encompassing technical skills, certification preparation, presentation, soft skill development, and teambuilding.

During the training period, apprentices work on the floor for at least two weeks under the guidance of mentors, who typically are ELTP graduates. This introductory OJT allows apprentices to become acclimated to the work environment and interact with managers and their peers. BCBSSC estimates that it spends an average of \$39,000 per apprentice on training, salary, and benefits during this period.

After the 16 to 20 weeks of classroom training, apprentices spend the next 42 to 48 months in an on-the-job apprenticeship, where they work full-time and continue to learn through OJT. At the conclusion of the apprenticeship, graduates will have completed an industry recognized certificate issued by DOL. In addition, all apprentices sign a two-year promissory note, guaranteeing that they will remain with BCBSSC for two years after the completion of the program.

Costs and Benefits

The most direct costs to BCBSSC come from the 16 to 20-week training program and apprentice wages throughout the entire ELTP. Each year, BCBSSC evaluates the market wages for similarly experienced employees in the region and sets wages to make positions attractive to potential entrants. In addition, BCBSSC monitors ELTP graduates for five years following completion of the program to ensure that their compensation is keeping up with their peers.

Additional direct costs over and above apprentice training and wages include curriculum development and a dedicated recruiter. Mentors play a key role in assigning apprentices to projects and tasks appropriate to their skill level to minimize the risk of costly errors and missed deadlines while allowing apprentices to build the

skills they will need for more challenging work. There are cost savings in this matching of skill level to work; having lower skilled and less costly resources doing lower level work is more cost effective for BCBSSC than using senior level employees and costlier resources.

BCBSSC cites a number of perceived benefits that are largely in line with those cited by other firms. Attrition rates are lower for ELTP participants than for employees hired from other channels, averaging around 4 percent, compared to an industry average of 13 percent. The average tenure of current ELTP-trained employees is nearly 10 years. As with several other apprenticeship programs, the ELTP provides a training ground for future leadership, with 22 percent of current ELTP-trained staff at BCBSSC in leadership roles. Executives see the ELTP as part of a pipeline that brings on new employees, trains them, and uses their knowledge and skills to train new employees coming in behind them.

The major benefit they cited, however, was the ability to inculcate a “Blue Cross culture” in younger, fairly inexperienced candidates. While many firms describe the building of loyalty and camaraderie as a core benefit of their apprenticeship programs, BCBSSC raised a more specific point: namely, that a great deal of their core system applications run in traditional mainframe environments, which are not addressed in many current computer science programs. ELTP provides a method of getting new employees up to speed within the existing work environment.

CVS Health

Location: Nationwide, with its largest programs in Michigan, South Carolina, and Georgia

Occupations of apprentices:

- Pharmacy technician
- Store manager

Company Web Address: <https://www.cvshealth.com/>

Background³³

CVS Health (CVSH) is a health care company with 9,600 retail pharmacies and over 1,100 walk-in medical clinics, as well as a pharmacy benefits management company with more than 75 million members. The company has more than 243,000 employees across the United States, and CVS pharmacies serve 5 million customers every day.

CVSH has a well-established and growing apprenticeship program primarily for pharmacy technicians. In 2005, CVSH became the first employer to start a DOL Registered Apprenticeship program for pharmacy technicians, adding store managers in 2008. The program began in Detroit, Michigan, where CVSH partnered with Wayne County Community College (WCCC), Goodwill Industries, churches, and other community organizations. The city of Detroit, through the Detroit Employment Solutions agency, contributed grant support to help launch the program. According to CVSH officials, the program exceeded all performance goals, including retention, preparedness, and finding quality candidates to fill positions.

In 2012, CVSH expanded its apprenticeship program to South Carolina following the 2007 launch of Apprenticeship Carolina. Apprenticeship Carolina is a statewide effort to expand apprenticeships in South Carolina through technical assistance from the South Carolina Technical College system and with an added enticement of a \$1,000 per apprentice employer tax credit. The South Carolina program is now CVSH's largest, with almost 200 apprentices graduating over the few months preceding our conversations with them.

Currently, pharmacy technicians make up 90 percent of CVSH's apprentices. In 2015, CVSH joined the LEADERS program, committing to double the number of apprentices from 1,500 to 3,000 by 2020 through program expansions to five or six more states.³⁴ The company also committed to share best practices at DOL or state-sponsored outreach events for employers. To date, CVSH has begun meeting its commitments by registering more than 2,000 apprentices, primarily in Michigan, South Carolina, and Georgia. The company is developing new programs for technicians in specialty pharmacy services and benefits management, as well as considering programs in logistics, nursing, and information technology.

Motivation

Workforce Initiatives, a department housed in Human Resources at CVSH, develops and manages partnerships with government and non-profit entities related to workforce development programs, including apprenticeship. Because apprenticeship regulations vary by state, an internal Apprenticeship Task Force was

³³ For more information on CVSH's apprenticeship programs, see: <https://cvshealth.com/about/diversity/a-prescription-for-career-success>.

³⁴ <http://cvshealth.com/social-responsibility/corporate-social-responsibility/leader-in-growth/safe-rewarding-inclusive-workplace>

assembled to assist in navigating multiple state program standards, which only sometimes match federal standards. The apprenticeship task force also develops partnerships with local organizations; typically, these groups are non-profits with an education focus. Current partners include National Park College in Arkansas, Houston Community College and Dallas County Community College District, Detroit Employment Solutions, St. Louis Works, the Milwaukee Area Workforce Investment Board, the Rhode Island Department of Labor and Training, Florida State Colleges, and Philadelphia Works.

When we asked about alternative hiring options to apprenticeship, CVSH officials stated that there are many paths to a career as a pharmacy technician. Many employees are hired into other, entry-level roles in the company, such as cashiers, and later selected for promotion into the pharmacy based on their interests and skills. CVSH also hires from local community colleges that have certificate or associate degree programs in the field. For CVSH, apprenticeship represents a “both/and” proposition rather than an “either/or.” In some markets, the skills they desire are more readily available than others, and localized skills shortages can drive their decision to use apprenticeship. Apprenticeship at CVSH also provides access and opportunities for more diverse job candidates, including women, people of color, people with disabilities, and veterans.

Recruiting

CVSH recruits apprentices beginning at either age 16 or 18, depending on state law, using a variety of sources: career centers, internal referrals, program orientations, or through community-based partners. Participants need to meet the requirements of the standard CVSH employee selection process and demonstrate a customer service orientation along with basic math and reading skills. All pharmacy techs in South Carolina go through the program, though some complete it much faster than others because of previous experience and skills, while Detroit’s program is opt-in, with approximately 35 percent of techs working through the program.

Program Details

CVSH’s pharmacy technician apprenticeship program is competency-based and 12 to 18 months in length. Apprentices move through a career path from pharmacy technician trainee to pharmacy technician to lead technician. After completion, apprentices receive a nationally recognized and portable credential from DOL.

Technical instruction and OJT cover prescription pickups, intake, and entry; medication pulling, counting, and packaging; and inventory management. Apprentices are supervised by the on-site pharmacist and are not permitted to counsel patients or take calls from physicians. In addition to the skills necessary to perform these functions, the apprentice curriculum also includes soft skill development, including customer service, leadership, managing, and scheduling.

Apprentices begin with a pre-apprenticeship, which CVSH cites as vital to the success of their program and particularly their outreach to non-traditional candidates. CVSH’s local partners conduct the bulk of recruiting in these non-traditional or sometimes less-skilled groups, and they also help to offset CVSH’s costs by teaching fundamental skills—particularly “soft” professional skills like punctuality and attendance—that prepare candidates for their apprenticeship and eventual career.

Once they finish their pre-apprenticeship training, apprentices move on to classroom training provided by certified trainers, most of whom are CVSH employees and all of whom are subject matter experts. Apprentices are taught a set of skills used in the pharmacy environment for two to four weeks and given web-based assessments to test their retention. Apprentices proceed to a training store to work in a live environment under the supervision of a pharmacy employee before being sent to their home stores with an evaluation of their skill needs.

In their home stores, apprentices work with a senior technician or the pharmacist to close any skills gaps. If needed, apprentices return to the classroom for additional instruction. Overall, this process takes 16 weeks, after which apprentices are fully engaged in day-to-day work operations for the remainder of their two-year apprenticeship.

Costs and Benefits

Apprentices earn stackable interim credentials from DOL as they master competencies, and CVSH is confident that its industry standards lend legitimacy to these credentials. As part of the progression from pharmacy technician to lead technician, the program requires apprentices to pass the national certification exam for pharmacy technicians. Some states also require apprentices to earn a state certification, and some community colleges give apprentices college credit for their training.

As with all the other apprenticeship programs we have studied, wages of trainers and apprentices are the principal cost of the program. CVSH pays apprentices a market wage commensurate with their skills and experience. Wages increase during the program as apprentices master additional skills and competencies. Soft skills, such as punctuality, are also included in performance reviews and factor into wage increases.

To judge success of the program, CVSH relies on feedback from their operations teams and an assessment of the apprenticeship completion rate. Overall, CVSH officials say that their community partnership programs (of which apprenticeship is one example) help reduce the turnover rate. Apprentices and others recruited through Workforce Initiative programs are twice as likely to be retained by the company over time.

Dr. Schneider Automotive Systems

Location: Russel Springs, Kentucky

Occupations of apprentices:

- Mechatronics technician
- Tool maintenance technician
- Injection mold setter

Company Web Address: <http://www.dr-schneider.com/en>

Background³⁵

In 1927, Dr. Schneider Unternehmensgruppe started manufacturing cigars in Neuses, Germany. Nine years later, the company added plastics manufacturing as a second line of business. The company dropped its cigar production in 1955 to focus on plastics and today Dr. Schneider Automotive Systems, as the firm is now known, is regarded as a high-quality automobile-related plastic products manufacturer. Dr. Schneider's products include ventilation systems, interior covers, instrument panels, and center consoles. The company today has 3,600 employees spread across seven locations worldwide, including Russell Springs, Kentucky. The 130,000-square-foot Russell Springs plant opened in 2014 and houses 39 injection molding machines. The company's 240 employees must be highly skilled to maximize the value of this equipment and serve its clients, which include German brands Mercedes Benz, BMW and Audi, as well as Ford Motor Company.

Motivation

Dr. Schneider's decision to establish apprenticeship programs in its Russell Springs plant reflects its dual roots as a German company and a Kentucky employer. Its German-born plant manager found that the Russell County labor market was not supplying sufficient skilled labor for the plant and that the company would have to recruit workers from outside the area. Wanting to recruit locally, the firm drew from its German experience with apprenticeships to develop the talent it needed while also strengthening the local labor force. The Tech Ready Apprentices for Careers in Kentucky (TRACK) initiative, an existing pre-apprenticeship program, provided the local support needed to get Dr. Schneider's U.S.-based apprenticeship program off the ground.

Recruiting

TRACK provides a pathway from career and technical education into a registered apprenticeship beginning in students' junior year of high school. Dr. Schneider works with the Lake Cumberland Area Technology Center and Russell County High School to recruit sophomores, who apply and interview with the company. The interview process is essentially identical to that used with regular employees. Applicants highlight why they want to take part in the apprenticeship program and demonstrate their readiness through their freshman and sophomore classwork. Typically, two or three students are ultimately selected and offered an apprenticeship at Dr. Schneider.

³⁵ For more information on Dr. Schneider's apprenticeship programs, see: <http://www.lanereport.com/64748/2016/06/youth-apprentices-excelling-at-dr-schneider-automotive-systems/>.

Program Details

Students enter the three- to four-year apprenticeship program in their junior year. They attend school in the morning, taking courses that Dr. Schneider selects in multiple subject areas encompassing maintenance of facilities, molds, and robotics, while also working a maximum of 30 hours a week while school is in session. After they graduate from high school or the technology center, students take additional classes at Somerset Community College in their selected field of study. Students also conduct training with Paulson, a computer based adaptable learning aid purchased by the company.

Over the first two years, apprentices will log 1,000 hours of paid OJT in mold setting, tool making, and mechatronics. In the first year, some apprentices are already programming robots. The company finds that after six to seven months many apprentices are at the same level as other workers. The tasks they perform may be less related to the apprentices' skill than to their age. For example, health and safety regulations prohibit a minor from operating an overhead crane. By the third year, apprentices are working without constant mentor supervision and begin handling the planning and implementation of projects.

Upon completion of the apprenticeship, students will have earned a TRACK certification in their selected field for their pre-apprenticeship training in the Lake Cumberland Area Technology Center. They also receive a journeyman certificate from DOL and some students choose to earn industry-specific certifications in skills, such as welding. They also earn an associate's degree from Somerset Community College as a result of the dual credit system that allows for the transfer of their technical center credits to their college transcripts.

Based upon available positions, apprentices are hired at the conclusion of their apprenticeship. During the personnel planning for the following year, graduating apprentices will be included in these calculations.

Costs and Benefits

The major cost for Dr. Schneider, like all the companies in this study, is apprentices' wages. Apprentices begin earning \$8.00 per hour their junior year and by their third year are earning \$11.50 per hour. Apprenticeship graduates earn around \$20.00 per hour if they are hired at the end of their program. Overall the company estimates that the yearly cost per apprentice is \$20,000 to \$30,000, with an additional \$6,000 to \$10,000 during the third year for community college tuition. Partly offsetting those costs are the lower recruitment costs afforded by the TRACK program, which provides a well-defined local pool of candidates at Lake Cumberland Area Technology Center and the local high school. Dr. Schneider estimates that it costs them 20 percent more to recruit employees off the street.

Because TRACK was already established, Dr. Schneider faced only very small start-up costs when they established their apprenticeship program. The curriculum that the apprentices use was already established in the TRACK program. Additionally, at the plant, apprentices use the same equipment as the current employees, so Dr. Schneider did not need to purchase any new equipment.

The company does not have internal metrics yet on the relative productivity of apprentices versus other workers, but it already values other benefits from its program that don't easily translate into dollars. Apprenticeship imparts company-specific knowledge related not just to the machines but also the company family—the people—with whom the apprentices are working. By becoming part of the family, apprentices are more likely to remain with Dr. Schneider. The program also honors the company's history as apprenticeship is a way of life in Germany and a way to strengthen the company's ties in its new Russell Springs Community.³⁶

³⁶ Although not directly related to its apprenticeship program, Dr. Schneider has also received performance-based incentives from the Commonwealth of Kentucky totaling \$7 million of corporate income tax credits and wage assessments by meeting job and investment targets. It also can receive up to \$195,000 sales and use tax incentives tied to construction costs, building fixtures, equipment used in research and development and electronic processing. That said, these incentives would not figure directly into the company's decision to use apprenticeships as one of its job expansion tools, nor directly reduce the cost of that investment to train local staff.

Hypertherm

Location: Hanover, New Hampshire

Occupation of apprentice: CNC machine operator

Company Web Address: <https://www.hypertherm.com/en-US/>

Background³⁷

Hypertherm is a Hanover, New Hampshire, based manufacturer of plasma, laser, and waterjet cutting systems. In partnership with Vermont HITEC, a non-profit workforce development organization, Hypertherm first began training CNC machinist apprentices in 2005 under a two-year program.³⁸ In 2007, the company established the Hypertherm Technical Training Institute (HTTI) as a first step in adopting the apprenticeship program created by Vermont HITEC. Vermont HITEC's training model emphasizes a short, intensive period of classroom training to get new (and sometimes incumbent) employees more skilled and productive quickly, followed by OJT at an employer.

Motivation

Hanover, along with the surrounding cities in New Hampshire and Vermont, was part of the region known as "Precision Valley" in the 1970s because of its booming machine tool manufacturing industry. In the 1980s, the industry began a decades-long decline and many precision manufacturing jobs left the area. Over time, and paralleling much of the rest of the country, many people in the area began to see manufacturing jobs as unattractive and as a dead end.

In 2005, management at Hypertherm estimated that the company would need to hire approximately 60 machine operators each year through 2009. At the time, the company only employed around 120 machine operators; increasing its workforce by 50 percent per year represented a sizeable expansion, and the local labor market was unable to supply enough recent graduates or experienced workers. The local community colleges and technical school graduated one or two qualified CNC machinists each year. The relatively remote location of the firm coupled with lack of skilled new entrants to the labor market led Hypertherm to apprenticeship.

In order to hire a substantial number of new machine operators, Hypertherm turned to Vermont HITEC for help. For several years, Vermont HITEC had been running a multi-employer program to provide technical training for CNC machinists in an intensive nine-week classroom session, at which point apprentices would join sponsoring firms for OJT. In 2005, rather than share sponsorship with other employers, Hypertherm decided to sponsor an entire class of 16 students, followed by a second class of 14 students.

Two years later, with the development of the \$2-million HTTI, Hypertherm brought the Vermont HITEC program onsite. HTTI's in-house lab is structured as a "room within a room," with employees receiving training in a classroom embedded within the shop floor. The lab is equipped with CNC machines to train employees in a non-production environment. Many of the machines are identical to ones that apprentices will use in production after their training; others are different but still allow for learning the processes on

³⁷ For more information about Hypertherm's apprenticeship program, see: <https://www.hypertherm.com/en-US/our-company/careers/career-areas/manufacturing/machine-operator-training/>.

³⁸ See Vermont HITEC case study for more information.

which Hypertherm relies. Additionally, the firm relies on a system called 5S lean manufacturing.³⁹ From the beginning, Hypertherm tries to instill the 5S principles in their workforce to keep them focused on efficient production with minimal waste. For example, at Hypertherm, every object has a designated storage space to which it must be returned after use, even including the salt and pepper shakers in the break room. The 5S principles are embedded in Hypertherm's corporate culture.

Recruiting

Initially, Vermont HITEC handled recruiting for the program. Radio and newspaper ads, press releases, the Vermont and New Hampshire Departments of Labor, ads on stubs for unemployment insurance checks, community organizations, and even flyers in the supermarket were used as a full-court press to find candidates for the Hypertherm apprenticeship. All of the ads emphasized that previous experience was not required, with a high school diploma or GED the only prerequisite. Hypertherm has since partnered with River Valley Community College to take over these duties.

Hypertherm screens candidates using a three-stage process. In the first stage, applicants learn about work in a machine shop, take tours of the floor, participate in a short interview, and take basic math and behavioral screenings. Hypertherm uses the second phase to assess cultural fit; production leadership interviews candidates and assesses their interest level, past technical experience, and motivation to take on new work. Finally, candidates participate in a classroom simulation with short lectures and quizzes. This phase is used less to judge candidates' performance than as a measure of how well candidates can represent themselves in a classroom environment where motivation and self-learning are key to success. In all, Hypertherm receives about 150 applicants for each class of apprentices, ultimately selecting up to 16 for each class.

After realizing that apprentices were performing better than veteran workers, Hypertherm began using its apprenticeship program to re-train the existing workforce. This contrasts significantly with other companies in this study, which rely on apprentices to fill some, but not usually all, positions for which they have apprenticeships. Currently, all but 10 Hypertherm machinists have been through the apprenticeship program.

Program Details

Hypertherm's two-year apprenticeship begins with nine weeks of intensive technical classroom and hands-on training. During this training, apprentices learn about lean manufacturing (which reduces waste in a manufacturing system) and the machining process. They learn how to read drawings and how to inspect and retool machines. The training puts all the concepts that apprentices need to know together from day one, rather than teaching one concept at a time.

Upon completion of the nine-week classroom and hands-on program at HTTI, apprentices receive an academic CNC machinist certificate from River Valley Community College and a pay increase. Apprentices then move to the shop floor to work under a mentor. This OJT portion of the apprenticeship lasts approximately two years, though Hypertherm uses a competency-based model that allows some apprentices to finish earlier if they are able to demonstrate that they have acquired the required skills. At the end of the program, apprentices receive a CNC machinist certificate from DOL. HTTI also offers two additional training programs for current Hypertherm employees beyond the basic CNC machinist program—a more senior machinist as well as production support technician—that employees are encouraged to complete if they are interested.

³⁹ 5S is a workplace organization method that originated in Japanese manufacturing. In Japanese, the five steps of the process are: seiri, seiton, seiso, seiketsu, and shitsuke. One English translation of these steps is: sort, straighten, shine, standardize, sustain. For more information, see <https://us.kaizen.com/knowledge-center/what-is-5s.html>.

Costs and Benefits

Hypertherm estimates that costs for the nine-week training program are about \$9,000 per apprentice. Additionally, mentors work with apprentices, but because mentors are still producing, Hypertherm does not explicitly quantify the costs of their labor hours for the apprenticeship program. Prior to the establishment of HTTI, apprentices were not paid until joining their home firm after the nine-week Vermont HITEC program. With the creation of HTTI, Hypertherm now pays all of its apprentices starting from the first day of their apprenticeship. Hypertherm believes that paying apprentices during the nine-week training builds employees loyalty. Additionally, it is an incentive to keep the training short and rigorous, which allows Hypertherm to get apprentices onto the production floor as quickly as possible. At the conclusion of the classroom training, apprentices receive a raise of \$1 per hour to \$14.50 per hour; they receive another raise when promoted to a second-level machine operator four months to a year later, based on the speed at which they master competencies.

Hypertherm's \$2 million investment in capital equipment to establish HTTI was a relatively large upfront cost compared to some of the other firms in the study. However, the company calculates that the program has more than paid for itself in productivity gains through reduced downtime and maintenance costs. Prior to training apprentices in the lab, new employees required approximately one year of training to get to the performance level that they now reach in nine weeks. During that first year, the new hires shadowed other employees, producing very little of their own work and potentially reducing the productivity of shadowed employees. Hypertherm estimates that reducing training time from one year to nine weeks has saved the company \$680,000 per year (based on an average of three classes, or 45 apprentices, per year).

Beyond the reduction in training time is the savings that Hypertherm has seen from reduced downtime and reduced maintenance costs. Hypertherm runs three operational shifts. As with many factories, the first shift—or the day shift, typically lasting from around 8:00 a.m. until 5:00 p.m.—is the largest shift and is when the vast majority of technical support personnel were available prior to the program. If problems or errors occurred during the “ghost” second or third shifts, workers would often have to wait until the next day's first shift for the problem to be resolved. During the downtime, Hypertherm was paying employees to wait idly. In 2006, Hypertherm had an average of six to eight machine crashes per week, with repairs ranging from \$10 to \$40,000. The time to get the machines up and running again ranged from 15 minutes to two weeks. By reducing the number of machine crashes, Hypertherm estimates that it has recovered \$300,000 per year in production time. Additionally, the company estimates it has avoided approximately \$50,000 annually in repair costs. Lastly, technicians are responsible for trying to self-diagnose machine errors for 30 minutes prior to submitting a request for assistance. By decreasing the number of these requests and the associated downtime, Hypertherm estimates that it has saved \$560,000 per year.

Together, Hypertherm estimates that reduced training time and increased work quality save nearly \$1.6 million dollars per year relative to its prior training methods. Such savings quickly offset the \$2 million investment to create the HTTI.

LaunchCode

Location: St. Louis, Missouri; South Florida; Kansas City, Missouri; Rhode Island; Seattle, Washington; Portland, Oregon

Occupation of apprentices: Computer programmer

Company Web Address: <https://www.launchcode.org/>

Background

LaunchCode is a nonprofit organization that acts as an intermediary, bridging the gap between potential employees and employers in the technology field through apprenticeship. LaunchCode either validates or trains potential IT candidates before placing them in hiring firms. To date, they have placed over 500 apprentices in firms in 10 different states ranging from small start-ups to large Fortune 500 companies. The success of LaunchCode's approach is evident: firms have converted 90 percent of the apprentices to full-time employees.

Motivation

LaunchCode breaks down the process of apprenticeship for firms that believe that apprenticeship will be time consuming, costly, and labor intensive. LaunchCode allows firms to engage in apprenticeship without incorporating new processes or infrastructure to their operations. Additionally, it opens up a new pool of employable candidates to the firm by working with diverse applicants whose lack of traditional or recent computer science training would lead companies to overlook them.

Recruiting

LaunchCode's approach is to provide IT professionals to firms that are comparable with a "normal hire," or someone that already has the skills and other qualifications needed to get the job done. Often, LaunchCode will tap into a pool of possible candidates that the firms might not consider on their own. For example, at MasterCard, one firm that takes on apprentices through LaunchCode, a typical hire has a four-year degree in computer science and three to five years of related work experience. However, only 15 percent of the candidates that come to LaunchCode have a degree in computer science. Some of those with degrees earned them decades earlier and have been out of the workforce for some time. Candidates with no computer science degree or with one earned in a time with very different IT systems would not be attractive hires to most firms. Furthermore, 30 percent of the candidates have no college degree.

Program Details

LaunchCode screens candidates with a desire to enter (or re-enter) the IT field, trains them in the skills needed, and places them in firms requesting talent. The program is competency-based and it generally takes candidates a year to fully develop the competencies needed for their position as a computer programmer, including pre-apprenticeship learning, applying to the program, LaunchCode's 20-week training program, skill validation, and OJT. The apprentices do not earn wages during the classroom period, but the training and job placement is provided to them free-of-charge. Additionally, candidates do not earn a degree or credential, but LaunchCode is currently working on an agreement with St. Louis Community College that will allow apprentices to earn 13 credits toward a degree when they successfully complete the 20-week

classroom training program. LaunchCode hopes to replicate this agreement in other markets. Only after LaunchCode validates their skills are candidates are placed in a firm to complete OJT.

Costs and Benefits

LaunchCode's model is very transparent and straightforward with respect to the employer costs of apprenticeship hires and hires of already-trained workers, which the company also facilitates. The company has worked with us to lay out the standard costs as well as some hypothetical figures to compare the costs and benefits of hiring through an apprenticeship versus an off-the-street hire. Because employers are working with an established intermediary, they face no start-up costs for building an apprenticeship program, but they do face apprentice costs for recruitment, wages, and training, as well as mentor costs. We outline those and compare them to the costs from the alternative of the employer hiring a fully-trained worker.

Recruiting and training apprentices

Employers first register online with LaunchCode to communicate their IT needs. LaunchCode recommends classroom-trained and validated candidates to the firms, who select candidates to interview. Firms have the option of bringing on the candidate as a direct hire or as an apprentice. All candidates are, in effect, already in an apprenticeship program, as they have completed the classroom portion of their training at LaunchCode and await placement or hiring by an employer to complete OJT. The employer decides whether to bring a candidate in for OJT and complete the apprenticeship program or to hire the candidate for a permanent position. For candidates that enter OJT, LaunchCode requests that firms ensure that there will be an open position for the apprentice to move into after the training is complete. For each apprentice graduate that is converted to a full-time permanent employee, LaunchCode bills the firm \$5,000 for their services. This fee covers the recruiting and classroom training. Companies also pay this fee if they make a direct hire instead of using OJT.

Apprentice and mentor wages

Apprentices begin working 40 hours a week and earning an apprenticeship wage, which is typically \$15 per hour, compared to \$25 per hour for a fully trained new hire. Given a 13-week training period of full-time work, the apprentice wage costs total \$7,800. LaunchCode estimates that new apprentices are about 80 percent as productive as the average normal hire.

Each apprentice is paired with a mentor, which LaunchCode describes as a “developer that employer wants to clone.” This is usually a higher-level employee (to value mentor time we assume they earn \$45 per hour). For this exercise, we estimate that mentors spend five hours a week away from their usual work training the apprentice. These five hours are hours that would otherwise be spent on their usual assignments and reflect lost productivity. Over the 13-week training period, mentor wage costs total \$2,925.

The true cost from lost output of mentors may be lower. LaunchCode told us that mentors often increase their productivity while working with apprentices because they are more focused on the task at hand and do not engage in bad habits that they otherwise might when working alone. LaunchCode and the firm work together to measure skill development during the OJT portion of the apprenticeship. The apprentice might need additional mentoring along the way, but LaunchCode promises the firm that they will receive quality candidates.

Total cost of apprentices

In sum, each apprenticeship directly costs employers \$15,725 if he or she is converted to a full-time employee. For multiple reasons, about 10 percent of apprentices are not hired in the end. If we take into account a pro-rated portion of their apprentice and mentor wage costs (assuming that they left the program halfway through), program costs increase by \$271, making the total cost of each apprentice hired as a full-time employee \$15,996.

Recruiting and training off-the-street hires

According to the Society for Human Resource Management, the national overall average cost-per-hire is \$4,500.⁴⁰ Recruiting also has indirect costs associated with the length of the time the position remains unfilled, but we do not attempt to quantify those costs. If firms were to hire workers through traditional channels, they may need to pay a signing bonus to secure talent, as trained IT professionals are in high demand. For this exercise, we have assumed a signing bonus equal to the gross bi-weekly earnings of an entry-level IT professional, or \$2,000. Training costs we assume to be \$0 because the hires are already trained, although it is likely that new hires do receive some firm-specific training after they are hired. In short, the out of pocket costs for hiring a fully trained worker are \$6,500.

Wages for off-the-street hires

During the 13 weeks that the OJT portion of an apprenticeship would last, an off-the-street hire would earn \$13,000, or \$25 per hour times 520 hours, but they also are 20 percent more productive than an apprentice according to LaunchCode. If wages reflected productivity, fully trained workers performing at an apprentice's level, therefore, should earn \$10,400. We assume off-the-street hires do not have mentorship costs. Like all workers, off-the-street hires require supervision, but we do not take such costs into account because apprentices have the same needs.

⁴⁰ These costs include third-party agency fees, advertising agency fees, job fairs, online job board fees, employee referrals, travel cost of applicants and staff, relocation costs, recruiter pay and benefits, and talent acquisition system costs, divided by the number of hires. See <https://www.shrm.org/hr-today/trends-and-forecasting/research-and-surveys/Documents/2016-Human-Capital-Report.pdf>.

Total cost of off-the-street hires

Adjusted for productivity, we estimate that each traditional hire cost firms \$16,900 (see Table 3).

Table 3. Comparison of Hiring an Apprentice versus an Employee Off-the-Street

Costs	Apprentice	Off-the-street hire
Recruiting and training	\$5,000	\$6,500
Worker wages	\$7,800	\$10,400*
Mentor time	\$2,925	\$0
Adjust for apprentice attrition	\$271	\$0
Total	\$15,996	\$16,900

**Adjusted for productivity.*

Putting it all together and reiterating that our numbers require various assumptions, the out of pocket costs for employers using LaunchCode are about \$900 less than when making off-the-street hires. These costs do not take into account any of the potential, long-term benefits that companies may see from reduced turnover or long-term differences in productivity of off-the-street hires and apprentices.

Outside of the money billed to firms, which accounts for about one-third of their funding, LaunchCode relies on government grants and private donations to operate. The grants support the LaunchCode approach of targeting workers with barriers to the IT industry. LaunchCode's experience has been that the candidates are thankful for the opportunity and generally develop a tremendous sense of loyalty to the firm that brought them in. Often the firms are skeptical at first, but then become excited about the opportunity to bring in non-traditional candidates who are vetted and validated. Firms also like that the cost to them is simple and reasonable.

The alternative for firms is to seek candidates through the traditional hiring process, which can be time consuming and expensive for IT jobs, especially if a recruiter is involved. Firms can also increase the hours and pay overtime to existing staff or hire contractors. LaunchCode's approach is attractive to employers and job seekers alike, offering new opportunities and growing the IT workforce.

Max Daetwyler Industries and Apprenticeship 2000

Location: Huntersville, North Carolina

Occupations of apprentices:

- Tool and die maker
- Welder fabricator
- Manual machinist

Organization Web Address: <http://www.daetwyler-usa.com/>

Background⁴¹

In 1995, four manufacturing firms with production facilities near Charlotte, North Carolina, founded the Apprenticeship 2000 consortium to offer apprenticeships in three occupations—tool and die tool maker, welder fabricator, and manual machinist—to graduating high school students. Blum, Sarstedt, Ameritech, and Daetwyler each only looked to train a few apprentices each year, but together would bring on a total of 10 to 15 apprentices. These four firms joined together to form a consortium. In the consortium approach, firms pool resources and work together to administer an apprenticeship program.

Motivation

Daetwyler Industries illustrates well the situation facing all four founding firms of Apprenticeship 2000 and other firms that participate in apprenticeship consortia. Like other manufacturers around Charlotte, Daetwyler had a difficult time finding skilled workers to operate specialty precision equipment at the pay rates it was offering. The company feared that it might go out of business if it did not fill those skilled positions. Daetwyler's Huntersville, North Carolina plant is home to approximately 75 employees. Like many small companies, its hiring needs are low—approximately one to three new apprentices each year at this location. Without the tradition or infrastructure to support apprenticeships that it had in its native Switzerland, Daetwyler and its partners, including Central Piedmont Community College (CPCC), saw value in trying to build a local infrastructure to create a pipeline of skilled workers for their jobs.

Together they established Apprenticeship 2000 and a four-year apprenticeship program. In this program, the first year coincided with students' senior year of high school. Today Apprenticeship 2000 has evolved to offer apprenticeships in several technical career trades including CNC machinist, tool and die maker, machine technician, mold/plastics technician, mechatronics electrician, and mechatronics technician. To date, the program has graduated 152 apprentices, and there are 47 in the program now.

Recruiting

Apprenticeship 2000 recruits high school juniors by making presentations at local schools, working with the schools' career counselors, and inviting students to attend an open house to learn more about the program. Candidates are invited to participate in a six-week internship over the summer between their junior and senior

⁴¹ For more information about Daetwyler's apprenticeship programs and Apprenticeship 2000, see: <http://www.daetwyler-usa.com/manufacturing/index.php?page=494>.

year of high school. The internship is an opportunity to screen the candidates further and determine which candidates are a good fit for the program and for each firm. For most firms in the consortium, it would be too costly and difficult to find the right candidates without this group approach.

Program Details

The apprentices, who begin the program in their senior year of high school, attend high school for half of each day and spend the other half of the day at their worksite. Upon graduating from high school, apprentices spend one day each week for the remaining three years taking classes at CPCC and work 32 hours a week as employees of Daetwyler or one of the other companies. At CPCC, the apprentices from various firms come together to take classes under the mechatronics curriculum.⁴² At each firm, they participate in specialized, firm-specific learning while working on the factory floor. Each company evaluates apprentices' performance and progress once a quarter, with favorable appraisals leading to pay increases. Upon graduation, students earn an associate of applied science degree in mechatronics and a nationally recognized journeyperson's certificate awarded by the state of North Carolina. They also are guaranteed a job that pays at least \$36,400 a year plus benefits.

Firms are responsible for providing an apprenticeship coordinator that works with other firms' coordinators to administer the Apprenticeship 2000 program. This includes administrative functions and recruiting.

Costs and Benefits

To join the consortium, firms pay \$5,000. There is no set annual fee for firms to retain their membership, but each company pays for their individual costs to run the program—this includes tuition, apprentices' wages, recruiting time, and the time of the apprenticeship coordinator. Starting this fall, however, the State of North Carolina will waive community college tuition for apprentices who start their apprenticeship while they are still in high school. Firms' costs are reduced by participating in the apprenticeship consortium because the consortium eliminates the need for firms to take on the full cost of developing and delivering a curriculum and the full cost of recruiting. When Apprenticeship 2000 program funds are running low, the partnership decides how much each member firm should contribute to replenish the coffer; all firms contribute the same amount regardless of the number of apprentices they have.

Additionally, Apprenticeship 2000 earns income when the group supports the development of a new partnership. A sister program, the North Carolina Triangle Apprenticeship Program (NCTAP), sprouted in Raleigh-Durham in 2013 with nine companies and three community college partners using the Apprenticeship 2000 program as a model. Apprenticeship 2000 typically charges other partnerships \$10,000 for the knowledge and documents they share to get the new programs up and running.

Daetwyler and the other Apprenticeship 2000 partners believe that they earn back the investment they make during the four years of the apprenticeship or shortly thereafter. Even if an apprentice were to leave the firm after graduating from the program, taking their experience and skills with them, the companies believe that they've already earned back a positive return on their investment. Fifty-three percent of graduates stay with Daetwyler for five years or more. Daetwyler has a very difficult time finding employees through traditional hiring methods that have similar skills to its apprenticeship graduates, so the benefits are large.

⁴² For general information, including curricula, on the CPCC mechatronics program, see: <http://www.cpcc.edu/et/academic-programs/mechatronics-engineering-technology-1>.

This is important because the difficulty of finding employees with the right skills was the major motivator for Daetwyler to enter into the Apprenticeship 2000 partnership in the first place.

Over the long run, Daetwyler believes that training employees as apprentices gives the employees the specific skills and also embeds the firm's culture. This creates more loyal and hardworking employees who feel invested in the firm. All the firms with which we spoke for this study expressed similar sentiment about loyalty.

MTU America

Location: Graniteville, South Carolina

Occupations of apprentices:

- CNC machine operators
- Engine assemblers
- Part assemblers
- Quality technicians

Company Web Address: <http://www.mtu-online.com/mtu-northamerica/company/>

Background⁴³

MTU America, a wholly owned subsidiary of Germany's Rolls-Royce Power Systems AG, manufactures off-highway power and propulsion systems. Their main products, diesel engines and distributed energy systems, are used in mine haul trucks, military vehicles, and marine vessels, as well as hospitals, data centers, and universities.

Motivation

Building on its history of apprenticeship in Germany, the firm instituted an apprenticeship program for industrial mechanics in the United States in 2012 as a way of bringing talent into the company and increasing the technical skills of workers in their Aiken, South Carolina plant and community. To date, 13 apprentices have graduated from the program.

Recruitment

The MTU apprenticeship program, based on the German model of youth apprenticeships, targets high school students attending the Aiken County Career and Technology Center, which offers a large pool of possible candidates for the six slots that MTU makes available to juniors each year. MTU begins recruiting candidates by asking teachers to identify potentially suitable students as early as ninth and tenth grade. Students who have an interest in a career in manufacturing; have passing grades, good attendance and conduct; and are self-motivated are good candidates.

Program details

Once selected, apprentices work four hours a week during their junior year while attending high school classes full time. During their senior year, they work seven hours a week, on average, while also attending high school full time. Over the summers after their junior and senior years, the apprentices work at MTU full time. During their junior year, apprentices are primarily learning during the OJT portion of the program, but by their senior year they are functional members of the production team at MTU.

⁴³ For more information about MTU's apprenticeship programs, see: <http://www.apprenticeshipcarolina.com/apprenticeship-month/company-spotlight-mtu-america.html>.

MTU provides the Aiken County Career and Technology Center with curriculum for in-school technical training such as blueprint reading, metal working, and measurement. Like all plant employees, the apprentices must also attend regular company courses on code of conduct, work ethics, and harassment. Finally, the Apprentice Coordinator from Germany provides training on reading blueprints, taking measurements, milling, and assembly of metal parts. The Apprentice Coordinator also helps prepare the students for their final exam, which includes both practical, hands-on testing and written testing.

Upon finishing the program, apprentices have earned a high school diploma, have gained significant work experience, and are awarded apprenticeship certificates from DOL and the state of South Carolina. The training program and examination are conducted in consultation with the Association of German Chambers of Industry and Commerce (DIHK) and in line with the German regulations for occupational training in metalworking. Upon completion of their final exam, the apprentices also receive an official graduation certificate for “Skilled Metal Workers,” which is recognized internationally.

Costs and benefits

As is typical with apprenticeships, apprentices contribute to the plants’ production at a reduced wage relative to full-time, fully-trained employees, and their pay progresses commensurate with their increasing experience and productivity. For their OJT hours, MTU apprentices earn a starting wage of \$8.75 per hour and they receive pay raises every six months through the program. If hired full-time upon graduation, they earn \$14.00 per hour. MTU apprentices do not receive a wage for the classroom training time. Besides wages, MTU pays approximately \$500 per apprentice for training and education.

MTU considers its program to be the most cost-effective way to fill its need for industrial mechanic labor, while also increasing the skills of the greater Aiken labor force and helping to alleviate a potential community problem of skill shortages. Currently, MTU employs only one of their youth apprentice graduates in their college co-op program.⁴⁴ Two of their 2016 graduates are set to begin the firm’s new maintenance apprenticeship program, which is currently in the process of DOL registration. Three graduates are employed by other firms in the local area. MTU is proud to help improve the skills of the local labor pool and surrounding employers have provided MTU with positive feedback.

When permanent positions are available, MTU offers them to apprenticeship graduates, and its goal is to retain its apprentices. That said, the firm considers that the benefits it gains during the two-year apprenticeship program cover its costs and does not rely on apprentices continuing with the firm as full-time employees for the program to pay off. One way to consider this cost-benefit calculation is to consider MTU’s alternatives for hiring industrial mechanics. An apprentice graduate is someone with a known skill set who has been trained specifically for his or her job and is familiar with the company. Alternatively, MTU would employ contractors or direct hires recruited through various channels including employee referrals, newspaper and Internet ads, and staffing agencies. All told, MTU estimates that it spends approximately \$3,000 to hire an employee, without taking into account the hires’ fit in the company and subsequent training costs. However, MTU has very low recruiting costs for their youth apprenticeship program. The school advertises the program through career counseling and the program has received free publicity through the local news media.

⁴⁴ For information on MTU’s college co-op program, see: <http://www.mtuamericacareers.com/student-worker-programs/co-op-programs>.

MTU also sees some indirect benefits of its apprenticeship program. Employees that serve as mentors benefit by reinforcing their own skills and report a feeling of camaraderie with the apprentices. Additionally, when apprentices graduate and there are not full-time positions available at MTU, they take their skills to the larger South Carolina workforce. This view is consistent with the company's German heritage, which sees apprenticeships as a natural part of the way they do business and as a way for the company to contribute to society.

North America's Building Trades Unions

Location: Nationwide

Occupations of apprentices: Numerous occupations fall under North America's Building Trades Unions (NABTU). See <http://www.bctd.org/About-Us/Affiliates.aspx> for a list of affiliate organizations.

Background

The building and construction trades represent the canonical example of apprenticeship in the United States. These trades—painters, boilermakers, electricians, bricklayers, plumbers, roofers, and so on—have used apprenticeships for more than 100 years to train new journeypersons in their crafts. For most people, the word “apprenticeship” likely calls to mind a member of one of these trades. To this day, the vast majority—almost two-thirds— of all apprenticeships registered with DOL are in the construction industry.⁴⁵ In addition, 74 percent of all construction apprentices are represented by NABTU.

Motivation

The NABTU apprenticeship programs are intended to provide a pipeline of skilled labor to the construction industry given the unique labor market conditions faced by construction firms. As one member of NABTU put it, construction is “the original gig economy.” Construction projects are necessarily short term, and the number of employees needed by a construction firm at any given moment varies depending on the firm's current workload. Many construction firms are very small, often single entrepreneurs who will switch back and forth from employee to business owner several times.

One of the major roles NABTU plays in the construction labor market is to act as a “hiring hall” where firms can take on workers for the duration of a project and then release those workers to other projects when they are finished. NABTU uses apprenticeships to provide a baseline level of skills and competencies that craft workers can transfer from job to job and employer to employer. As is becoming more common across all industry sectors, NABTU also sees providing diverse labor—including women, minorities, and veterans—as an important goal of their apprenticeship programs.

Recruiting

The program is intended for anyone looking to enter into skilled craft occupations. However, there are concerted efforts to reach out to populations that are less likely to have the resources to gain occupational skills on their own. NABTU works with state and local governments and community-based organizations to target minorities, women, and veterans. The “Helmets to Hardhats” program is specifically targeted to help military veterans learn the skills needed to be successful in an occupation in construction and to help them transition back to civilian life. The program has helped place over 20,000 veterans since its inception in 2003.

Program Details

NABTU has a large apprenticeship infrastructure with over 1,600 training centers in the United States, collectively known as the joint apprenticeship and training committee (JATC). Journey-level training provided by these centers includes: health and safety programs sanctioned by the DOL Occupational Safety and Health

⁴⁵ Source: DOL's Employment and Training Administration.

Administration; foreman training; instructor certification; and other skill upgrade training such as welding or painting certification. Another program, the Nuclear Mechanics Apprenticeship Process, teaches journey-level workers cutting edge skills used in manufacturing nuclear-related products.

The length of apprenticeships in the building trades varies by occupation. For craft workers in the finishing trades—painting, floor covering, window glazing, and similar crafts—apprentices are required to complete a minimum of 144 hours of classroom training per year for between two and five years. The classroom curriculum includes theory, methods, hands-on practice, and development of leadership skills. In addition to classroom work, apprentices complete 2,000 hours of OJT each year. The training model is a hybrid model, allowing apprentices to test out of some academic requirements but requiring the full completion of OJT.

Much of the training that apprentices receive can be applied toward an associate's or bachelor's degree, so the NABTU apprenticeship programs are a head-start for workers that would like to continue their education further. Apprentices in the finishing trades earn up to 42 credit hours that can be applied to future degree requirements.

Costs and Benefits

According to the NABTU Research Department, if the JATC were a college or university, it would be the second largest in the country. The JATC centers are privately funded through contributions in excess of \$1.3 billion per year from the building trades unions and the contractors that hire unionized labor. The building trades unions use dues from current members to fund the training needs of future members, establishing an intergenerational link across the entire membership that NABTU believes is one of the core elements of its longstanding success with apprenticeship. The natural progression among skilled craft workers from apprentice to journeyman to mentor further cements this relationship across time.

The finishing trades unions spend \$3,000 to \$4,000 per apprentice for training and education, while employers are responsible for wages. Completion rates are not well tracked, but the majority of dropouts likely occur early before many costs accrue. The Construction Industry Craft Training Research Team stated that NABTU employers earn an ROI of between \$1.30 and \$3.00 for every \$1.00 invested in craft training due to improved safety, increased worker productivity, and reduction of rework, absenteeism, and turnover.

Oberg Industries

Location: Freeport, Pennsylvania

Occupations of apprentices:

- Precision toolmaker
- Precision tool grinder
- Press operator
- CNC operator - milling
- CNC operator - turning
- CNC operator - mill/turn
- CNC machinist - milling
- CNC machinist - turning
- CNC machinist - mill/turn
- Heat treater
- CAD die designer
- Precision machining specialist
- Precision grinding specialist
- Carbide punch and die operator
- Precision EDM operator

Company Web Address: <http://www.oberg.com/>

Background

Founded in 1948, Oberg Industries is a contract precision manufacturer headquartered in Freeport, Pennsylvania. This employee-owned company has three manufacturing sites worldwide, employing approximately 700 at its two locations in Pennsylvania and 100 in Costa Rica. The company specializes in multi-axis machining, turning, electrical discharge machining (EDM), grinding, lapping, metal stamping, and tooling for numerous consumer and industrial markets including aerospace, energy, medical, defense, and metal packaging.

Motivation

At its core, Oberg sees itself as “selling skills” more than manufactured goods. It has operated training programs since 1953 to build a highly skilled workforce that can “make their machines sing and dance” and “maintain future generations of skilled workers.”⁴⁶ The company began registering its apprenticeship programs with DOL in 1971. Over the years, Oberg has graduated nearly 700 apprentices. The majority of its current staff are graduates of one of its 15 apprenticeship programs. Another 42 apprentices are currently in training.

⁴⁶ For more information about Oberg Industries’ apprenticeship program, see: <http://www.oberg.com/about/careers/apprenticeship-program.aspx>.

Oberg is growing at a rate of about five percent per year and the company invests approximately five percent of revenues in capital equipment each year. Beyond growing their capital stock, Oberg also needs to “grow” new employees in order to sustain this growth. Hiring fully skilled staff from other companies is not an easy alternative because there simply are not enough skilled workers to hire.

Recruiting

Selection for Oberg’s apprenticeship program is competitive. The company seeks independent, creative self-starters who perform well under pressure and are not afraid of challenges. Applicants must have a high school diploma or equivalent but do not need previous experience to apply for entry-level positions.

Oberg screens applicants through industry-approved tests, psychological batteries, and interviews. For the stamping apprenticeship, the industry-approved test is the Precision Metalforming Association’s Metalworking Skills Assessment.⁴⁷ For apprenticeships in other fields like CNC, grinding, and tooling, applicants take the National Tooling and Machining Association’s Employee Aptitude Test.⁴⁸ Oberg typically only hires about 5 to 10 percent of applicants.

Once hired, apprentices must continue to show progress by earning a grade of 80 percent or more on their classroom assessments and demonstrate proficiency of the required competencies for the job.

Program Details

All of Oberg’s apprenticeships are competency-based and typically take between two and four years to complete. Oberg had time-based apprenticeships for over 20 years but found that they were better suited to jobs with repetitive tasks and simple product lines. Oberg’s varied work as a contract manufacturer requires an agile manufacturing staff that is flexible enough to produce constantly changing products with superior quality and a high rate of precision. Now, instead of using time-based programs, Oberg aligns its competencies to customer expectations and strategic objectives that promote an extensive cross training process encompassing multiple machines and product lines. This allows management to send the workforce where manufacturing constraints exist to reduce cycle time and increase machine utilization. The competency based programs also align with a performance based reward system much better than time-based programs.

Related instruction is a combination of online, video-based, instructor-led, and distance learning classes. Apprentices attend instructor-led or distance learning classes a few days a week but complete online or video-based classes daily. All OJT and classes take place within the company during the work shift; there are no after-shift or off-hour classes. Instructors are college faculty and in-house subject matter experts. This blend of classroom and OJT continues throughout the apprenticeship. Oberg partners with Butler County Community College (BC3) so apprentices can earn a college certificate and obtain college credits during their apprenticeship program. They also partner with Penn State University to provide non-credit classes to specific apprenticeship programs.

Apprentices will earn industry credentials from the National Institute of Metalworking Skills (NIMS) during their apprenticeship program. The number and type of NIMS credential earned depends on the

⁴⁷ A description of and order form for the Metalworking Skills Assessment is available at: <http://www.pma.org/public/marketplace/pdf/MetWorkSkillsAssessBrochure.pdf>.

⁴⁸ For more information, see the National Tooling and Machine Association’s Fact Sheet available at: http://www.ntma.org/uploads/general/Guide_-_Employee_Aptitude_Test.pdf.

apprenticeship program selected. Industry credentials are given college credits through articulation agreements with academic partners. Upon completion of the program, apprentices will earn a journeyperson certificate and a cash bonus. Apprentices also receive bonuses for each industry credential they obtain. Oberg's apprentices often progress to administrative or senior management jobs in the company and former apprentices have occupied both director and vice president positions.

Costs and Benefits

Oberg invests up to \$250,000 per apprentice in hourly compensation, bonuses, related instruction, and benefits over a four-year apprenticeship period. These costs take into account overtime premium pay that some apprentices earn, as well as pay increases that those progressing satisfactorily will achieve every six months.

Oberg was one of the few companies we studied that conducts internal ROI calculations on its hires. In its calculations, Oberg is able to distinguish apprentices from non-apprentice hires, as well as track specific cohorts of hires. Oberg has been doing these analyses for almost 15 years. Based on Oberg's internal metrics, there is greater risk in hiring off-the-street "experienced" employees than developing employees through an apprentice program. This is largely due to a high degree of variability in experience gained from other employers and the costs to get off-the-street hires up to speed and acclimated to their unique manufacturing process. Because of this and the graying of the workforce, Oberg is looking to double its number of apprentices over the next two years. Because of confidentiality concerns, Oberg did not share detailed data with us, but we can provide an overview of how the company conducts its analysis and the results. Its approach may well be a model for other companies to follow.

Oberg starts by using the same metrics that it tracks for company production. Metrics for training effectiveness follow the guidelines first recommended by an outside expert. Its basic ROI metric compares the actual cost to the predicted cost of a job or task. Jobs are broken down into tasks and the tasks are assigned to machine tools. Benefits are included in the cost calculations. This analysis helps the company determine ongoing training needs for all manufacturing employees. Other metrics that the company tracks include indirect labor hours, direct labor hours, training hours, scrap costs, rework costs, and machine hours. These numbers feed into measures of apprentice productivity, labor utilization, and ROI.

Finally, the company also tracks apprentices' progress through their class grades, number of competencies demonstrated, and percent of competencies completed. All these measures allow Oberg to examine the ROI of apprentices during the training program. The apprentice graduation rate is over 85 percent. These measurements are correlated to the recruitment and selection process to improve targeting sources of new hires.

Oberg finds a wide-range of consistently positive ROI for its apprentice graduates on average. Typically, the company's ROI on apprentices is negative for the first 12 to 18 months depending on the program. Most programs show a positive ROI by the midpoint of the program. However, the most dramatic increase in ROI usually occurs during the last year of the program. The apprenticeship process is structured and repeatable. All programs are reviewed annually and revisions are common due to technology changes and customer demands. In the end, all apprentices receive the same training and learn how to perform tasks the "Oberg way."

United Automobile Workers-Ford Motor Company

Location: Headquartered in Dearborn, Michigan; apprentices are trained at sites nationwide.

Occupations of apprentices:

- Industrial electrician
- Millwright
- Tool and die maker
- Machine repair
- Plumber/pipefitter
- Toolmaker
- Welder
- Metal model maker
- Industrial truck mechanic

Organization Web Address: <https://uaw.org/> and <http://www.ford.com/>

Background⁴⁹

The United Automobile Workers-Ford Joint Apprentice Program is a partnership between the United Automobile Workers (UAW) labor union and Ford Motor Company that began in 1941. Although the program has changed over the years, what remains the same is the commitment to developing a skilled workforce. There are currently almost 600 Ford employees enrolled in the UAW-Ford apprenticeship program and another 1,200 expected over the next three and a half years.

Motivation

Although this apprenticeship program has been around for 75 years, the program was mostly dormant for over a decade until the economy and the manufacturing sector began to emerge from the Great Recession. The manufacturing sector was hit especially hard, and many schools stopped providing the technical training they had previously offered. The auto industry stopped hiring and actually shed workers from 2000 until around 2010, creating a gap in the workforce between older, skilled workers and young, unskilled workers. UAW-Ford is using the apprenticeship program to re-skill their workforce and prepare for the retirement of many veteran employees.

Recruiting

In most apprenticeship programs, firms hire apprentices from the outside labor market as a way of training new workers. In the UAW-Ford program, however, Ford apprentices come from the current Ford labor force. Although the program is necessary to train newly hired and younger workers, the program also serves as a way to upskill workers who have worked in manufacturing—at Ford or elsewhere—for some time. A number of the apprentices in the program are over 50 years old. Because technology is ever-changing, there are always new skills to learn. For workers that are new to Ford, the training is imperative to learning how to do things the Ford way.

⁴⁹ For more information on UAW-Ford apprenticeship programs, see: <http://uawford.org/apprentice/>.

Full-time Ford employees, in order to qualify for the apprenticeship program, must complete the Industrial Readiness Certificate Program (IRCP). The program consists of three standardized courses completed through one of 12 approved local community colleges or completed online with Penn Foster Career School. The three courses cover shop arithmetic, machine tool blueprint reading, and trade related preparation. After completing the three courses, candidates submit a transcript and preference for three trades for review and approval. If approved, candidates are placed on a waitlist according to seniority, and apprentices are selected from this list.

Program Details

Apprentices begin with a three-week core skills course at Ford's Technical Training Center (TTC) in Lincoln Park, Michigan, to learn basic knowledge and skills about their trade. Apprentices then complete rotational on-the-job assignments with journeypersons in their trade, as well as coursework at their local educational provider and some additional periodic advanced training at the TTC. The total time spent in the apprenticeship must include 8,000 hours of on-the-job time in the shop and a minimum of 576 hours of related educational training. The average apprenticeship requires approximately three and a half years to complete.

Institute for American Apprenticeships at Vermont HITEC

Location: Williston, Vermont

Occupations of apprentices:

Healthcare

- Certified medical transcriptionist
- Certified medical coder
- Certified phlebotomist
- Certified medical assistant
- Certified pharmacy technician
- Licensed nurse assistant
- Practice support specialist
- Registration representative
- Electronic health record go-live support analysts
- Electronic health record data abstractor
- Cancer tumor registrar

Information Technology

- Software developer (Java)
- Web developer
- Development programmer
- Support programmer
- EDI analyst / programmer
- Software installation consultant
- IT support analyst
- IT account manager
- IT interface analyst
- IT application software analyst

Advanced Manufacturing

- CNC machine operator
- Machinist
- Structural steel welder and fitter

Business Services

- Technical documentation writer

Organization Web Address: <http://www.vthitec.org/>

Background

The Institute for American Apprenticeships at Vermont HITEC (Vermont HITEC) is a non-profit workforce development organization that has been acting as a “workforce intermediary” leader in Vermont and New Hampshire for over 16 years, developing and implementing apprenticeship programs in the non-traditional fields of healthcare, IT, advanced manufacturing, and technical services. It acts as a workforce “broker” between employers who have immediate job openings to fill but cannot find skilled workers and job seekers looking for immediate employment but lack the necessary skills employers need. Vermont HITEC has been approved as a Workforce Innovation and Opportunity Act (WIOA) Eligible Training Provider, a Vermont apprenticeship sponsor, and has joined DOL’s RA College Consortium as a sponsor member.⁵⁰

Vermont HITEC, through the use of its accelerated workforce development and competency-based apprenticeship model, closes the gap by providing employers the newly skilled workforce they need. Apprenticeship acts a cornerstone of Vermont HITEC’s model. Specifically, every participant selected and enrolled in a Vermont HITEC accelerated pre-apprenticeship education program who graduates is guaranteed full-time employment in an apprenticeship at a livable wage with full benefits. In the past 15 years, this model has been used to create over 1,400 new jobs in 20 different non-traditional apprentice occupations for more than 25 regional employers.

Motivation

Vermont HITEC’s educational programs are all employer-partner sponsored. Starting with guaranteed jobs for all of its successful graduates, the programs that Vermont HITEC offers are specifically designed to provide the education and skills needed for specific occupations. Beyond the technical skills, Vermont HITEC helps students gain the “communications, human relations, citizenry, and analytical skills” that employers value in their employees.

From an educational perspective, Vermont HITEC programs have the rigors of an academically-reviewed curriculum and have been awarded college credits through Burlington College and the earning of necessary position-specific credentials through national certifications by examination. From the student’s perspective, Vermont HITEC’s model involves career and program orientation, aptitude assessments, interviewing and selection, accelerated pre-apprenticeship education, coaching and mentoring, immediate transition into employment, and intensive mentoring in a competency-based registered apprenticeship. From the employer’s perspective, the model involves business and workforce analysis, recruitment, reverse-engineered curriculum development, education delivery, apprentice transition into the workplace, performance standards and metrics, performance reviews, mentoring, and retention. This accelerated model can be used in any industry for any occupation.

Program Details

Three of the firms with whom we spoke during our study have worked with Vermont HITEC to design and deliver curriculum for their apprenticeship programs. As noted elsewhere in this report, Vermont HITEC worked closely with Dartmouth-Hitchcock to reverse engineer the MA occupation to develop a 10-week classroom training. Vermont HITEC also provides instructors to Dartmouth-Hitchcock to teach the classroom portion of the apprenticeship training.

⁵⁰ The Registered Apprenticeship-College Consortium is composed of employers, labor-management groups and associations that have Registered Apprenticeship programs (known as sponsors) and two-and four-year postsecondary institutions. For more information, see: <https://www.doleta.gov/oa/racc.cfm>.

In addition to Dartmouth-Hitchcock, Vermont HITEC currently works with nThrive (formerly Precyse) to develop and deliver curriculum for their medical coding apprenticeship program. Vermont HITEC also worked with Hypertherm, an advanced cutting products manufacturer, to reform their apprenticeship training in 2005 and continues to recruit apprentices for Hypertherm today. Although health care, medical coding, and machinist occupations differ greatly, Vermont HITEC's model for providing the classroom training for apprenticeship in these occupations is the same. Unlike many apprenticeship programs that blend classroom and OJT over the entire apprenticeship period, Vermont HITEC's model is to provide intensive classroom training up front before the apprentices begin OJT. The classes are held at an employer designated site or online, as is the case with Precyse. Apprentices are expected to study and complete homework on a subject before they learn it in class. The classroom instruction is meant to reinforce the concepts with the apprentices mostly teaching each other and the instructor acting as a facilitator.

All apprentices in Vermont HITEC programs keep daily journals as a method of tracking their progress and communicating with instructors. The instructors provide daily written feedback and also correct grammatical errors in the journal entries to help the apprentices improve their communication skills.

Appendix I: Quantitative Results

The study team visited Dartmouth-Hitchcock in Lebanon, New Hampshire and the Siemens plant in Charlotte, North Carolina, to interview the senior executives overseeing the apprenticeship programs, as well as several apprentices and mentors, in order to gain a thorough understanding of their programs. Subsequent to our visits, we reached agreements with Dartmouth-Hitchcock and Siemens to gain access to more detailed production and cost data, which has allowed us to statistically assess costs and benefits of their apprenticeship programs. The results of that analysis are presented and discussed in the case studies in the report. This appendix provides a detailed description of the study team's data analysis.

Dartmouth-Hitchcock

From our discussions with physicians, managers, medical assistant graduates and trainees, we found that the MA apprenticeship program had the following potential impacts:

- reduced costs, due to reduced overtime of all providers, and lower wages of MA's.
- increased the hospital's ability to deliver care, by making sure available appointment times were filled and by allowing providers to spend time examining patients rather than rooming them
- increased provider satisfaction due to increased time spent delivering care they were trained to do
- increased patient satisfaction, because of reduced wait time to obtain an appointment,

We used data provided by DHMC to analyze some of these potential effects. In particular, we looked at whether the introduction of apprentice MAs in the Lebanon facility had an effect on the number of hours that patients were seen for appointments and the number of patients up to date on their preventive care procedures. Separately, we did a preliminary analysis of quality of care metrics, as measured by the provision of preventive care, specifically colonoscopies and the flu vaccine.

The main method we used to analyze these data is called difference-in-difference, a technique used to understand the effect of a policy change. This is done by comparing outcomes before and after a policy change has been implemented in a treatment group (a group receiving the policy change) to the outcomes in a control group (a group not receiving the policy change). The assumption is that the trend in the control group is a good approximation of what the trend would have been in the treatment group absent a policy change. The difference-in-difference approach has been used to measure many different policy changes including the effectiveness of drugs on health outcomes or educational programs on student success. In the classic case of difference-in-difference the treatment group are comprised of individuals all of whom receive a policy change while in the control group are comprised of individuals who have not received the treatment.

There are two main components of difference-in-difference analysis, a time variable that indicates the time of the policy change and a variable that denotes which group received the treatment. In the case of D-H there are actually three time periods (the three dates the medical assistants started working at Lebanon) and the

treatment is on the facility and not individuals. Ideally the treatment group would be the specific physicians and nurses with medical assistants, but data matching particular physicians and nurses to particular medical assistants is not available.

Lebanon is the treatment group while Manchester is the control group. There are four different time periods:

1. No apprentice MAs: January 2012 through October 2014
2. 21 apprentice MAs: November 21 through May 2015
3. 40 apprentice MAs: June 2015 through November 2015
4. 55 apprentice MAs: January 2-16 through June 2016

We considered Manchester to be a sound control group because both facilities operate under the same corporate management, in the same state, and in the same industry. We must note, however, that booked hours did tick up in Lebanon prior to the apprenticeship period, reflecting in part the move to the Heater Road facility and the use of provider overtime hours instead of MAs. There was not a comparable uptick in booked hours at Manchester. Based on our extensive interviews with Dartmouth-Hitchcock management and staff, we do not consider this uptick to be sustainable over the long term. Ultimately, there remains a question about what booked hours in Lebanon would have been in the absence of the MA apprentices. In our analysis, we implicitly assume that hours would not have continued increasing relative to Manchester.

MA placement schedule:

	First day of work	Total Number of Apprentices Placed	Primary Care – Heater Rd.	General Internal Medicine	Lyme	Pediatrics
Cohort 1	Nov-14	21	15	6		
Cohort 2	Jun-15	19	11	8		
Cohort 3	Dec-15	18	8	7	1	2

Primary Care Appointments

The primary care appointment file has information on appointments from January 2012 to June 2016. Fields of interest were:

1. A unique identifier for each provider
2. The facility of the provider (Lebanon and Manchester)
3. The cost center of the provider (primary care, internal medicine, and family medicine)
4. Booked hours: the number of hours spent at appointments that day
5. Date (month and year)

A time category was created to represent the four time periods of MA placement.

The original dataset included 114,364 observations:

- Because medical assistants were concentrated in primary care, internal medicine, and family medicine all other cost centers were dropped (39,588)
- We dropped some observations because appointments were not linked to a particular provider (2,005)

Sample:

Provider	Region	Date	Booked hour
0001	Lebanon	Jan-12	4
0001	Lebanon	Feb-12	7
0001	Lebanon	Mar-12	5
0002	Manchester	Jan-12	3
0002	Manchester	Feb-12	4
0002	Manchester	Mar-12	3

Booked hours were then summed by month and facility, leaving 108 observations.

$$\text{Booked Hours} = \beta_0 + \beta_1(\text{Lebanon}) + \beta_2(\text{ERA: 21 MAs}) + \beta_3(\text{ERA: 40 MAs}) + \beta_4(\text{ERA: 55 MAs}) + \beta_5(\text{ERA: 21 MAs}) \times (\text{Lebanon}) + \beta_6(\text{ERA: 40 MAs}) \times (\text{Lebanon}) + \beta_7(\text{ERA: 55 MAs}) \times (\text{Lebanon})$$

β_7 represents the effect of having 55 MAs on the number of booked hours.

From January 2012 through October 2014 (right before the first cohort of MA's started working) providers in the Lebanon facility were seeing patients for 3,368 appointment hours per month. From the time the third cohort began working in December 2015 through June 2016 appointment hours jumped to 4,128 a month an increase of 760 hours, or 23 percent. Booked hours in the Manchester facility also rose, from 1,933 to 2,376, a difference of 443 hours. The difference in the difference is therefore 318 hours. This result is represented by 3.era#1.treated.

Booked Hours by Cohort

	(sum) booked_hr
1bn.era	-101.227 (1.00)
2.era	85.223 (0.79)
3.era	442.933 (4.36)**
1.treated	1,434.632 (24.18)**
1bn.era#1.treated	235.559 (1.64)
2.era#1.treated	546.169 (3.56)**
3.era#1.treated	317.551 (2.21)*
Constant	1,933.159 (46.07)**
R^2	0.92
N	108

* $p < 0.05$; ** $p < 0.01$

Preventive Care Procedures

Providers, physicians and nurses, have multiple patients who have recommended preventive care procedures. Based on data availability, we looked at colonoscopies and flu vaccines. The preventive care file has the number of procedures administered and the number of procedures recommended to be administered for each provider from January 2012 through May 2016. Procedures recommended are based on characteristics of patients including medical history, age, and risk factors.

The fields used for analysis are:

1. A unique identifier for each provider
2. The facility of the provider (Lebanon and Manchester)
3. The procedure (colonoscopies and flu vaccines)
4. Procedures administered
5. Procedures recommended
6. Date (month and year)

A time category was created to represent the time period after November 2014.

Because of multiple data issues, extreme caution should be used in drawing conclusions from these results. The original data set contained 14,860 observations. Data issues include:

- Data were not available for October 2013 or November 2015
- If administered or scheduled procedures were missing those observations were excluded (7,937)
- Because of data issue in December of 2015 and January of 2016 those observations were excluded (774)
- Because of a definitional change data on mammograms, and other issues, these data were excluded (4,608)
- Because of a data outlier in colonoscopy procedures in Manchester in June of 2014, these data were excluded

Sample:

Provider	Region	Measure	Date	Recommended	Performed
0001	Lebanon	Colonoscopy	Jan-12	110	91
0001	Lebanon	Colonoscopy	Feb-12	98	78
0001	Lebanon	Colonoscopy	Mar-12	133	111
0002	Manchester	Flu shot	Jan-12	46	27
0002	Manchester	Flu shot	Feb-12	35	27
0002	Manchester	Flu shot	Mar-12	50	40

Procedures were summed by month, region, and procedure. This leaves 98 observations for flu vaccines and 96 observations for colonoscopies.

$$\text{Measure} = \beta_0 + \beta_1(\text{Lebanon}) + \beta_2(\text{Post Nov2014}) + \beta_3(\text{Post Nov2014}) \times (\text{Lebanon})$$

Using these very limited data 838 more patients were up to date on their flu vaccines while 194 more patients were up to date on their colonoscopies, although the latter result was not statistical significant.

Siemens USA

Data

In order to estimate the productivity benefits from the Siemens apprenticeship program, the study team received two large data files and other supporting documentation from Siemens. The data files are described in more detail below.

Labor Audit Trail

Each time a Siemens employee clocks in or out on an operation, his or her hours are recorded. The Labor Audit Trail is a record of all such transactions from October 1, 2015, through August 31, 2016, for all machinists employed by Siemens in its Charlotte turbine facility. Of the fields provided in the data set, the following were used for analysis:

1. A unique identifier for each employee
2. The order number for each project
3. The operation type performed
4. The date and time at which the employee clocked in
5. The date and time at which the employee clocked out
6. Elapsed time (derived)

The data contained 90,156 observations over the 11-month study period.

Order Operation Hours

For each operation on each project, Siemens sets a target time. Because employees may clock in and out several times on the same operation—and several employees may all contribute to the same operation—the Labor Audit Trail contains no information on target times. The Order Operation Hours file provides that information with much less detail. Of the fields provided in the data set, the following were used for analysis:

1. The order number for each project
2. The operation types performed on each project
3. Planned labor (target time) for each order/operation pair
4. Actual labor performed for each order/operation pair

The Order Operation Hours file contained 12,533 order/operation pairs. For various reasons—including non-machinist work performed and inclusion or exclusion of break time—the actual labor listed in the Order Operation Hours matched the sum of labor hours for each order/operation pair in the Labor Audit Trail in only 66percent of cases. Non-matching cases were excluded from analysis after the study team determined that they were not significantly different from matching cases in terms of mentor hours or difference between planned and actual time.

Other Information

In addition to these two data sets, Siemens also provided a list of all machinists with their job categories and grade levels. In the absence of detailed employment history, using employee grade levels can help estimate the

relative experience of each employee and control for expected differences in productivity that are unrelated to mentor status.

Finally, Siemens provided a class schedule for their apprentices during the study period. Each apprentice was in class certain days during the week but present on the shop floor other days. In addition, each apprentice was assigned to a specific mentor. Using this information, the study team estimated when a given machinist in the data was likely to have an apprentice present and when that would be unlikely.

To understand the relationship between actual time and planned time, while controlling for various employee-level factors, it was necessary to transform the Labor Audit Trail data into an operation-level dataset. Because multiple employees can contribute labor to any operation, the study team calculated the percentage of total hours contributed to each order-operation was calculated for each of the following employee groups:

1. Mentors working alone (on days when apprentices were in class)
2. Apprentice graduates
3. Mentor-apprentice pairs (on days when apprentices were on the shop floor)
4. Low experience workers, defined as workers in grades 1 through 5 (of 8 total grades); given internal promotion procedures at Siemens, these were workers likely to be in their first three years of employment
5. High experience workers, defined as workers in grades 6 through 8 (excluding mentors, who were drawn exclusively from these grade levels and are represented in groups 1 and 3 instead)

The following sections present a detailed summary of the study team's findings for the benefits of the Siemens apprenticeship program.

Overview of Results

Using the existing data, there are four kinds of benefits apprentices and apprentice graduates might provide:

- I. Better adherence to planned times per production schedule.
- II. Higher capacity, because apprentice grads are even more productive than pre-trained off-the-street hires.
- III. Filling a job that would otherwise go unfilled, in which case the entire margin on the apprentice's product counts as a benefit, because that product would not otherwise have been produced.
- IV. Increased capacity to do a variety of jobs, such as machining new generators and repairing old ones.

The costs and benefits of apprenticeship are measured using the "internal rate of return," or the rate of return generated by investing in the apprentice's training upfront.

The study team finds that, compared to hiring a machinist off the street, apprentices are less likely to be late and achieve a level of productivity that is even greater than other low-experience pre-trained workers. Based on our analysis of this scenario, these direct benefits yield an internal rate of return of about 8 percent over hiring existing labor.

We also explored the benefits of apprentice flexibility and found a much larger return. In fact, we found that the program would easily pay for itself by the end of a journey person's first year. Compared to off-the-street hires or even other Siemens employees with much greater experience, apprentice graduates are all cross-trained on a variety of tasks and can be assigned to almost any operation.

To the extent that the local labor market is unable to supply off-the-street hires with the right skills at the wage being offered, then the alternative to apprenticeship is likely to be leaving a position unfilled and turning down work—either by declining contracts or extending deadlines on all work to create schedule slack, which have the same financial impact in the long run. In this case, the benefit of having an apprentice graduate is the entire margin of that employee’s work. Given the margins on Siemens’ products—large, complicated, advanced energy-producing machinery—the program would easily pay for itself by the end of an apprentice graduate’s first year of full-time work.

I. Adherence to planned time: Apprentice graduates are less likely to exceed planned time.

During the study team’s tour of the Siemens facility, employees emphasized the importance of keeping to the schedule. Exceeding planned time created a variety of problems, such as extra crane moves, idle machines, and workers at other stations. The study team analyzed the benefits of apprentice graduates using several definitions of late: any time an operation took longer than the planned time, as well as actual times that were one, two, or four hours over the scheduled time. The team used regression to estimate how the probability of a project running late was affected by the percentage of hours contributed by each of the employee groups defined at the beginning of this section.

The analysis shows that if only low experience employees worked on an operation, approximately 33 percent of jobs would be more than two hours late. Substituting an apprentice graduate would decrease the proportion of late jobs by 20 percentage points, down to 13 percent of total jobs.

The next step is to calculate how much it is worth to reduce late jobs by 20 percentage points. On average, an operation lasts approximately 9 hours. For a low experience worker, a 2,000-hour work year would include around 220 jobs, of which 33 percent, or 74, would exceed planned time. Siemens estimated that this lateness would cost an average of \$500 (with wide variation), for a total lateness expense of \$37,000 per worker.

By contrast, an apprentice graduate, with a lateness rate of only 13 percent, would have about 29 late jobs per year, for on average of only \$14,500 in lateness expense. Reducing lateness using apprentice graduates would save approximately \$22,500 per year in lateness expenses per worker.

II. Costs of capacity: Apprentice graduates are more productive than similar pre-trained hires

The study team used the following regression equation to evaluate the productivity of apprentices in comparison to similar pre-trained low-experience workers, their most direct comparison group:⁵¹

$$\text{Actual time} = \alpha * (\text{planned time}) + \beta_1 * (\text{percent of work})_I + \sum \gamma_i * (\text{percent of work})_i * (\text{planned time}) + \varepsilon,$$

where $(\text{percent of work})_I$ is the percentage of hours contributed to each operation’s total actual time by each of the employee groups defined at the beginning of this section.

This analysis shows that apprentice graduates are even more productive than their low-experience peers. An average operation in the data lasts approximately 9 hours, and apprentice graduates save six to eight minutes, for a total savings of about \$500 per year per worker. While this benefit is smaller than the previously-discussed benefits from reduced lateness, it illustrates that Siemens is succeeding in training machinists with little or no prior experience.

⁵¹ This procedure alleviates problems with ratios described by Kronmal, R.A. (1993), “Spurious correlation and the fallacy of the ratio standard revisited,” *Journal of the Royal Statistical Society, series A*, 156: 37-392, at https://www.jstor.org/stable/2983064?seq=8#page_scan_tab_contents.

In fact, the analysis also shows that apprentice graduates have productivity similar to or greater than even their mentors, who are highly experienced machinists often with decades of experience. Officials at Siemens suggested that the intensive training their apprentices receive likely accounts for this increased productivity. Apprentice graduates are less experienced than their mentors but often have a more detailed knowledge of theory, machine programming, tool design, and even esoteric subjects like metallurgy.

Finally, the analysis shows that mentors have approximately the same productivity whether they are working with apprentices or not. Due to small subsamples, there was not enough data to separate out the performance of mentors in tandem with beginning apprentices and those with working with more advanced apprentices.

Costs and benefits of timeliness and cheaper capacity

If the local labor market is able to supply off-the-street hires to perform the duties of a low-experience worker, then the annual benefits from using apprentices are approximately \$23,000 per year, beginning when the apprentice graduates from the program—approximately four years after hire. The total net cost of training is calculated as follows:

Costs (per apprentice)

Wages and training costs	\$181,000
Pre-apprenticeship and internship	\$5,000
Administration and recruiting	\$1,000
Total costs per apprentice	\$187,000

The total costs of apprenticeship, however, should be offset by the cost of hiring the off-the-street hires that Siemens would require in the absence of apprentices. We estimate the cost of hiring a low-experience worker in the local labor market at \$56,000, making the net cost of apprenticeship only \$131,000.

To calculate the internal rate of return, the study team constructed a stream of benefits of \$23,000 per year over a 40-year career with Siemens, subtracting off the upfront cost of \$131,000 per apprentice. The calculation yielded an annual internal rate of return of 8 percent, for a modest but positive investment performance. Due to the effects of discounting cash flow over a long time horizon, shortening the assumed length of the apprentice’s career has little effect on the analysis.

III. Costs of vacancy

The above calculations assume that Siemens is able to hire pre-trained machinists in the local labor market instead of apprentices. If the local labor market is unable to supply off-the-street hires, however, then the alternative to apprenticeship is likely to be leaving a position unfilled and turning down work—either by declining contracts or extending deadlines on all work to create schedule slack, which have the same financial impact in the long run. In this case, the benefit of having an apprentice graduate is the entire margin of that employee’s work. Given the margins on Siemens’ products—large, complicated, advanced energy-producing machinery—the program would easily pay for itself by the end of an apprentice graduate’s first year of full-time work.

IV. Value of variety

In addition to their relative productivity, one of the key benefits of apprentice graduates is their flexibility. Compared to off-the-street hires or even other Siemens employees with much greater experience, apprentice graduates are all cross-trained on a variety of tasks, so they can be assigned to almost any operation. In particular, two kinds of flexibility are important at Siemens:

- a. the ability to work on almost any machine if demand for operations requiring that machine is higher than usual or if the person who usually runs that machine is on leave, and
- b. the ability to repair existing generators and turbines (in addition to building new ones).

Both of these types of value are potentially quite large. The data collected by Siemens, however, makes estimation of the first type of benefit difficult, so the study team focused on the value of the second type of flexibility. Because apprentice graduates have a strong grasp of the principles of their work—as well as the ability to read blueprints and program machines—they are particularly well suited for tasks involving judgment, such as repair work. The plant seeks work servicing pre-existing generators and turbines when it has excess capacity.

The plant would like to ensure that it has enough capacity to complete all orders for new generators in a reasonable (and contractually specified) time. However, demand fluctuates. Data we received from Siemens suggests that given the value of generators and fluctuations in demand, the plant on average should maintain about 20 percent flexible capacity.⁵² If the plant has apprentice graduates, and if demand for repair work is sufficient to fill the 20 percent flexible capacity, it can use this downtime to perform repair work. We make the strong assumption that workers hired off the street cannot perform this work, which may allow us to capture the value of the first type of apprentice flexibility as well. In this scenario, the internal rate of return easily reaches 50 percent and can be higher. Although these assumptions are a bit crude, they capture a robust finding: since apprentice graduates have the necessary skills and judgment to take on complex work and fill slack time in the plant by doing this type of repair work, Siemens can rapidly recoup the costs of training—likely within the first year of apprentice graduates working full-time.

Conclusion

Using a conservative estimate of the benefits of apprentice graduates—reduced lateness and greater productivity relative to other low-experience workers—the study of Siemens’ internal data shows that apprenticeship has an internal rate of return of approximately 8 percent. Without internal knowledge of Siemens’ finances, it is impossible to say how this compares to other investment opportunities the company may have, but the evidence shows that Siemens receives a positive net return on apprenticeships even under a restrictive set of assumptions. If Siemens—and many other companies in this study—are correct, and the local labor market cannot supply low-experience workers to compete with apprentices, the benefits of apprenticeship are significantly higher.

In addition, we find that apprentice graduates’ ability to perform many types of work make the program especially compelling. Since apprentice graduates have the necessary skills and judgment to take on complex work and fill slack time in the plant, Siemens can rapidly recoup the costs of training—likely within the first year of apprentice graduates working full-time. Finally, these estimates are necessarily conservative because they exclude a variety of potential benefits, such as improved quality control, lower turnover, and the creation of a durable pipeline of skilled labor and management.

⁵² For methodology to determine optimal operation when a plant has the ability to make both a time-sensitive product with fluctuating demand and a time insensitive product, see “Options-Based Costing and the Volatility Portfolio,” Suzanne de Treville, Kyle Cattani, Lauri Saarinenan, University of Lausanne Working Paper, 2016.

Appendix II: Literature Review

In general, existing ROI studies rely on a model that compares apprentice output during the course of the program to the training, wage, and other costs associated with the apprentice. Some include indirect benefits as well, such as reduced recruitment and on-boarding costs associated with off-the-street hires. We see two main challenges faced by these and similar studies. First, calculating apprentice output is very difficult, whether because of the nature of a firm's products or often because a firm's work processes do not allow one individual's productivity to be easily disentangled from a larger group, team, or even plant. In many cases, because apprentices are not treated as regular employees for administrative purposes, their hours and output are not tracked by the same systems used for their coworkers. Existing research tends to work around this difficulty by making educated assumptions about worker productivity, whether using subjective performance reviews or asking firms to estimate the relative productivity of an apprentice compared to a fully-trained worker. Real data on apprentice productivity is difficult to obtain.

In addition, these studies approach the calculation of ROI largely from an accounting perspective rather than an economic perspective. While some include cost savings associated with hiring apprentices rather than advertising, on-boarding, and training already-skilled workers, very few identify a counterfactual case—that is, what are the costs of getting the same work in some other way? At what cost could the firm have hired workers “off the street,” and how would the productivity of those workers compare to apprentices? What were the firm's overall productivity gains from apprenticeship, and how much of those gains can be attributed to apprentices rather than other secular business cycle factors? Constructing such a counterfactual, identifying a control case, and rigorously analyzing company data would provide a much more robust picture of the value of apprenticeship.

An overview of some of these studies and their findings are below.

Return for Businesses

Much of the previous work done to estimate the ROI of apprenticeship for businesses has focused on the European apprenticeship environment, particularly in Germany and Switzerland, which have the most robust apprenticeship systems. This body of literature is summarized in great detail in many other papers and reports, so we will present only a brief overview here.⁵³

A few common threads emerge from much of the literature. First, the net cost of apprenticeship varies fairly widely across firms, suggesting that apprenticeship is not a one size fits all model. For instance, there is evidence that apprenticeships in unskilled or semi-skilled occupations serve as a substitute for traditional labor in those fields, yielding a profit over the course of the apprenticeship itself; apprenticeships in more skilled fields, however, may be better understood as human capital investments that will pay off further into the

⁵³ Robert Lerman of American University and the Urban Institute has written a particularly succinct and informative review of the existing literature. See Lerman, Robert. (May 2014), “Do firms benefit from apprenticeship investments?” IZA World of Labor. Available at: <http://wol.iza.org/articles/do-firms-benefit-from-apprenticeship-investments.pdf>.

future, regardless of whether they pay off during the apprenticeship period itself.⁵⁴ Our study mainly focuses on firms that use apprenticeship to fill skilled positions.

Second, even averaging net costs over all firms in a given country, there is substantial variation across countries. A 2013 paper for the European Commission gathered evidence from other studies on apprenticeships in Germany, Switzerland, Austria, and the United Kingdom, finding that Swiss firms were the only ones, on average, that received net benefits during the apprenticeship itself.⁵⁵ More than 60 percent of Swiss firms found that apprenticeships were profitable within the apprenticeship period itself, compared to around 35 percent in Austria, 30 percent in Germany, and 0 percent in the UK.

Conversely, retention rates for apprentices in Germany are much higher than in Switzerland – above 50 percent in Germany and around 35 percent in Switzerland. Whether these retention rates represent a firm-level response to differences in profitability or underlying labor market realities that condition the initial design of apprenticeships is unknown, but they indicate that a thorough understanding of ROI should consider future streams of net benefits beyond the end of the apprenticeship. Indeed, evidence from the UK shows that, while none of the studied firms showed positive profits over the apprenticeship period, all were likely to recoup their costs within one to three years following completion of the program.⁵⁶

Finally, evidence from a forward-looking projection of apprenticeship in Spain indicates that firm size may also play a role in apprenticeship profitability.⁵⁷ Overall, while the authors' model estimates that apprenticeship could have average net benefits, larger firms would generate larger net benefits than small firms. In fact, small firms with fewer than 10 workers would be much more likely to incur net costs. This difference is attributable both to economies of scale, due to the large fixed costs of setting up and maintaining an apprenticeship program, as well as the relative gap between wages paid to apprentices and fully-trained workers at large and small firms.

Return for Apprentices

There is also existing research on the benefit of apprenticeship to the apprentices themselves. In the American context, the most well-known and thorough work was done by a team at Mathematica Policy Research.⁵⁸ Specifically, the goal of the Mathematica study was to determine whether Registered Apprenticeship is a way to raise the annual wages of participants and if the social benefits outweigh the social costs. The study concluded that participants who completed their apprenticeship programs earned, on average, over \$240,000 more over their careers than nonparticipants. Additionally, the study found that the social benefits outweigh the social costs by \$49,000 over the career of an apprentice, justifying the investment of resources into such programs.

⁵⁴ Mohrenweiser, Jens and Thomas Zwick. (March 2008), "Why Do Firms Train Apprentices? The Net Cost Puzzle Reconsidered," Centre for European Economic Research (ZEW), Discussion Paper No. 08-019. Available at: <ftp://ftp.zew.de/pub/zew-docs/dp/dp08019.pdf>.

⁵⁵ Muehleemann, Samuel and Stefan C. Wolter. (November 2014), "Return on investment of apprenticeship systems for enterprises: Evidence from cost-benefit analyses," IZA Journal of Labor Policy, 2014 03:25. Available at: <https://izajolp.springeropen.com/articles/10.1186/2193-9004-3-25>.

⁵⁶ Gambin, Lynn, Chris Hasluck, and Terence Hogarth. (2010), "Recouping the costs of apprenticeship training: employer case study evidence from England," Empirical Research in Vocational Education and Training, Volume 2, Number 2, 2010, pp. 127-146(20).

⁵⁷ Wolter, Stefan C. and Samuel Muehleemann. "Apprenticeship training in Spain," Study commissioned by Bertelsmann Stiftung and the Fundación Bertelsmann. Available at: http://skbf-csre.ch/fileadmin/files/pdf/news/Apprenticeship_training_in_Spain.pdf.

⁵⁸ Reed, Debbie, Albert Yung-Hsu Liu, Rebecca Kleinman, Annalisa Mastri, Davin Reed, Samina Sattar, and Jessica Ziegler. (July 2012), "An Effectiveness Assessment and Cost-Benefit Analysis of Registered Apprenticeship in 10 States," Mathematica Policy Research. Available at: https://wdr.doleta.gov/research/FullText_Documents/ETAOP_2012_10.pdf.

Another study of workforce training programs in the state of Washington also found net benefits for apprentices.⁵⁹ The study found that, over the short term, apprenticeship participants saw a nearly 50 percent increase in average quarterly earnings due to increased levels of employment, higher hourly wages, and increased work hours. Longer term benefits were also positive but smaller, indicating that apprenticeship may provide a jump start while other kinds of worker training take longer to have an impact.

While research on the benefits to apprentices—or overall social benefits—is valuable for policymakers and workforce development agencies, this study’s focus is confined to the direct benefits for sponsoring or participating firms, who ultimately are the ones making the investment in the apprentices

⁵⁹ Hollenbeck, Kevin and Wei-Jang Huang. (2006). “Net Impact and Benefit-Cost Estimates of the Workforce Development System in Washington State,” W.E. Upjohn Institute for Employment Research. Available at: http://research.upjohn.org/cgi/viewcontent.cgi?article=1023&context=up_technicalreports.

