WORKING PAPER

Future of manufacturing

United States: Policy developments on apprenticeship

Adaptation of national apprenticeship systems to advanced manufacturing

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Introduction

Scope of the research

This country report is part of the study 'Policy developments and practices of apprenticeships in selected EU Member States and world competing regions' carried out in five EU (Denmark, Germany, France, Ireland and Italy) and two non-EU countries (Australia and the USA). This study is conducted in the frame of the Pilot Project 'The Future of Manufacturing', proposed by the European Parliament and delegated to Eurofound by the European Commission (Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs).

One of the objectives of this study is to provide an analytical overview of apprenticeship systems in the selected countries and to review changes to the current systems following labour market shifts, changes in employment, career and mobility patterns and technological and structural change. Particular emphasis is placed on the impact of new technologies and the need for a high skilled and adaptable workforce in manufacturing and advanced manufacturing.

This research is carried out in response to the increasing interest in apprenticeships among policy makers to tackle skills mismatches but also to integrate young people into the labour market. The appeal of apprenticeships is also growing particularly in a context where new technologies are transforming work organisation and production processes across all sectors, particularly manufacturing.

The findings from this research will feed the policy discussions around the role of apprenticeships for the future of manufacturing and inform policy making in the context of current or planned reform of apprenticeship systems and the necessary links to be established between education/training and industrial policies.

Report structure

With a view to investigating country specific issues, the first section outlines the wider economic and labour market context in which the national apprenticeship system operates. The links between education/ training and industrial policies are also explored.

The second section describes the key features of the national apprenticeship system, including the regulatory framework, the governance structure, and the financing mechanisms and it provides some statistical data on apprenticeships and pinpoints the key challenges to the implementation and the development of the current apprenticeship system.

The focus of the third section is on the specific role of apprenticeships in relation to the advanced manufacturing industry in the US. It examines the main requirements arising particularly from technological change in manufacturing and it explores recent reforms on apprenticeship systems together with the key drivers behind these policy changes. In doing so, it identifies success factors and barriers to the implementation and the development of apprenticeship systems.

This country report is based on a literature and document review, as well as five qualitative semi-standardised interviews with selected key actors and stakeholders, namely the U.S. Department of Education, the National Association of Manufacturers, the trade union United Auto workers and the Office of Apprenticeship in the U.S. Department of Labour (see list of consulted stakeholders in annex 2).

Key terms at a glance

Apprenticeships are structured programs of occupational training that emphasise work-based learning, related academic (usually classroom) instruction, production by apprentices, and certification of occupational competence. Companies, groups of companies, and trade unions become registered apprenticeship sponsors by registering with the U.S. Department of Labour's Office of Apprenticeship, or in about half the states within the U.S., with the state departments of labour. A program sponsor is required to specify the skills apprentices will learn, often the number of hours devoted to learning each skill at the workplace, the requirement for wage progression during the apprenticeship, and various other regulations. Some U.S. companies offer unregistered apprenticeships that involve in-depth work-based learning and academic instruction required for an occupation but do not register their programmes with either the federal or state labour departments.

Registered apprenticeships in the U.S. make up a small share of the labour force. Civilian apprenticeships registered with federal or state governments make up only 0.26% of the labour force. However, in recent years, policymakers have begun to appreciate the potential role for apprenticeship in expanding opportunity and filling skills gaps. Funding increased in the last two years of the Obama Administration, which embraced the goal of doubling the number of registered apprenticeships in five years. Subsequently, President Trump endorsed the goal of achieving five million apprenticeships and recently signed an Executive Order involving steps to streamline the registration system and to create a Task Force to expand apprenticeship (Lerman 2017). Several major policy conferences have been held on apprenticeship-related issues, such as Apprenticeship Forward and a 2016 manufacturing conference organised in the frame of a new Manufacturing Policy Initiative. This shows the increasing interest in apprenticeships among congressional representatives, governors, and policy researchers, which also touched upon apprenticeship issues. However, despite agreement on the need to improve the way Americans prepare for careers, apprenticeships still play only a minor role in the U.S. system of education and training.

Advanced manufacturing is defined by the U.S. government as a family of activities that (a) depend on the use and coordination of information, automation, computation, software, sensing and networking, and/or (b) make use of cutting edge materials and emerging capabilities enabled by physical and biological sciences, for example nanotechnology, chemistry and biology. In involves both new ways to manufacture existing products and the manufacture of new products emerging from new advanced technologies (President's Council of Advisors on Science and Technology, 2011). Because advanced manufacturing encompasses 'new ways' to manufacturing existing products, there is no clear way to distinguish advanced manufacturing from other manufacturing.

Economic and labour market context

Economic and employment role of manufacturing and key trends

Resilience and recovery are good descriptions of recent trends in the U.S. economy. The financial crisis of 2008-2009 hit the labour market hard, raising unemployment rates to 10% and leading to the loss of over 7 million jobs. The U.S. GDP suffered serious declines in late 2008-early 2009. The employed share of the adult population fell from 62% to 58%. However, since 2009, the labour market slowly recovered. It took five years for jobs to reach their pre-crisis levels and seven years for unemployment rates to fall below the 5% levels of 2007. GDP recovered more quickly, reaching its 2008 peaks in 2011 and growing slowly after 2011 (U.S. Bureau of Economic Analysis, 2017). Still, even by 2016, the employment-population ratio remained below pre-recession levels (U.S. Bureau of Labour Statistics, 2017).

Manufacturing production has been declining modestly as a share of U.S. production in the business sector, falling from over 14.5% in 1997 to 13.2% in 2016 (U.S. Bureau of Economic Analysis, 2017). However, the declining share of private sector workers employed in manufacturing is far greater. In 1997, about one in six private sector workers held jobs in manufacturing. By 2016, only about 10%, or one in 10 private sector jobs, was in manufacturing, a rate far less than the 16% in the EU. Job losses in U.S. manufacturing have slowed from 3% per year between 2000 and 2007 to about 1.3% per year from 2007 to 2016 (U.S. Bureau of Labor Statistics 2017). The patterns vary widely by state. Since the trough in 2009 until early 2016, California managed only a 4% increase in manufacturing jobs, while in Indiana, manufacturing employment jumped by 18% (U.S. Bureau of the Census, 2017).

Notwithstanding its weak jobs picture, a variety of reports suggest a current and future shortage of skilled workers in manufacturing. Some academics, consulting firms, and managers argue that the weak skills of many American workers are leading to skill shortages and limiting potential economic growth (Deloitte and Manufacturing Institute, 2015). Manufacturing companies complain about their inability to find laser welders and advanced machinists to expand and to replace their aging work force. Others reject the skill shortage hypothesis and assert that skills in the United States are not in short supply (Cappelli, 2014; Osterman and Weaver, 2014). But one striking indication of a skills gap or mismatch is that German manufacturing companies operating in the United States identify job skills as a key challenge to their success in the U.S. and have encouraged the German Embassy to start a 'Skills Initiative' to identify and share information about best practices in sustainable workforce development (Embassy of Germany, 2017; Kamm and Lerman, 2016).

The aging of the workforce goes together with declining jobs in manufacturing. Between 2000 and 2016, California saw its share of older (age 55+) manufacturing workers increasing more than double from 13 to 27%. In Indiana, the 55+ year-old workforce rose from 13 to 24% of manufacturing jobs. Over the same period, manufacturing jobs declined by 36% in California and 24% in Indiana (U.S. Bureau of the Census, 2017).

The presence or absence of skill gaps is a complex matter because it depends on how employers respond to the supplies of skilled workers. When such supplies are highly limited and expected to be limited in the future, employers may shift production to other countries, change industries, or change the mix of skills used in production away from skilled, technical workers. In short, distribution of jobs depends partly on skills supply, which in turn depends on the quality and mix of students coming out of the education and training system. A system that provides workers with relevant technical skills is attractive for employers who can offer jobs requiring skills that result in high productivity. A good example is the education and training systems of Germany and Switzerland. These dual work-based and school-based systems have proved especially responsive

to skill requirements in manufacturing and may be responsible for the ability of these countries to sustain high levels of manufacturing employment.

Overview of industrial policy initiatives addressing advanced manufacturing

The idea of industrial policy is a controversial in the U.S. Market-oriented economists and many political conservatives argue against "picking winners" by favouring one industry over another (Ketels, 2007). Others favour providing special help to some industries, including those said to promote environmental goals (solar panels and electric cars), research-oriented firms, and manufacturing companies. The high point of proposals to promote specific industries came during the 1980s, when US manufacturing in many advanced sectors began to lose ground to Japan. Among the initiatives were government projects aimed at preserving the U.S. semiconductor industry. More recently, the Obama Administration launched a supercomputing initiative to strengthen US leadership in computing technology. Trade restrictions have often favoured specific industries, such as the steel and sugar industries. Also common are subsidies to encourage small businesses and to stimulate economic growth in disadvantaged geographic areas (Subcommittee for Advanced Manufacturing of the National Science and Technology Council, 2016).

Among the initiatives involving manufacturing are federal government investments in research, innovation and dissemination of best practices. The goal of the Manufacturing Extension Program (MEP) is to improve the competitiveness of firms by accelerating the usage of appropriate manufacturing technology by smaller U.S.-based manufacturing firms. MEP is a national system of 600 field locations in all 50 states and Puerto Rico. Each centre is a partnership between the federal government and a variety of public or private entities, including state, university, and non-profit organizations. MEP centres offer expertise, needs assessment, and training related to shop floor improvements.

MEP is a public-private partnership, designed from inception as a cost-share program. Federal appropriations pay one-third, with the balance for each centre funded by state / local governments and/or private entities, plus client fees. This cost-share model encourages centres to leverage resources and improve partnerships with other organizations and to emphasize services that are valued by manufacturers.

Additional support for advanced manufacturing comes from government research and development spending and an array of tax credits for research and development and for specific industries (Joint Committee on Taxation, 2015). Direct government spending on research and development averaged over $130 billion in the 2009-2013. The favourable tax treatment of research and development expenses amount to about $10 billion in recent years. Other credits are available for energy-related manufacturing industries.

Employment and training challenges linked to technological change and automation

Concerns over the loss of jobs associated with automation go back decades. Reports over the years reflect strikingly common themes. In 1964, President Lyndon Johnson and the Congress established a national commission to study the impact of automation on jobs. In words that can be uttered today, it argued:

> *'There should be no thought of deliberately slowing down the rate of technological advancement…The task for the decades ahead is to direct technology to the fulfilment of important human purposes. In the new technology, machines and automated processes will*

> *do the routine and mechanical work. Human resources will be released and available for new activities beyond those required for mere subsistence. The great need is to discover the nature of this new kind of work, to plan it, and to do it. In the longer run, significant changes may be needed in our society—in education, for example—to help people find constructive and rewarding ways to use increasing leisure.'*
>
> (U.S. National Commission on Technology, Automation, and Economic Progress, 1966)

The report distinguished between unemployment associated with macroeconomic shortfalls and displacements of workers associated with technical change. While downplaying the potential impact of automation on aggregate unemployment, the report nonetheless dealing with the problems facing individual workers by recommending public service employment, income maintenance, and education and training. Highlighting the importance of education in determining employability, the report made the case for universal high school graduation, funding for two years of free postsecondary education, and lifelong learning. It proposed giving community colleges the role of integrating theoretical foundations of occupations with the opportunity for 'learning by doing'. Yet, it offered no recommendation for employer-led training like apprenticeship.

In the 50 years since 1966, when the size of the U.S. economy quadrupled, warnings of automation taking over jobs have continued. But, recent well-documented reports draw similar conclusions to those in the 1966 report about the effects of future automation on employment i.e. no overall job reduction but rather shifts in jobs and displacement. The 2017 report by the McKinsey Global Institute is a good example (Manyika et al, 2017). Like Johnson's Technology Commission, the McKinsey report argues that technological change involves displacement but does not lead to high unemployment, since displaced workers can move to other jobs. The McKinsey authors see the potential, ultimately, to automate half of today's work activities but point out that no more than 5% of jobs can be automated. But, President Obama's Council of Economic Advisers argued that 83% of jobs paying under $20/hour are "under pressure from automation" by only 4% of jobs paying more than $40/hour are (Furman, 2017). In dealing with the displaced, Furman argues for job training, relocation assistance, and licensing reform. Among the advanced manufacturing positions in demand are engineers in several fields, coordinate measuring machine (CMM) operator and programmers, robotics technicians, and advanced machinists.

Given the dire warnings about automation displacing workers, one would expect to observe dramatic increases in the ability of the economy to produce increasing output with fewer workers. In fact, the growth in labour productivity has been meagre in the U.S. Since 2000, output per worker has increased at less than 2% per year. Over the last five years, productivity growth averaged less than 1% per year, even in manufacturing. At the same time, U.S. unemployment rates have dropped sharply (Sprague, 2017).

Notwithstanding these macroeconomic trends, there are certainly workers displaced by technological changes as well as trade, changing market patterns, and competition among firms. In 2013-2015, 3.2 million workers who had worked in their job for at least three years lost their job (U.S. Bureau of Labour Statistics 2016). Although two-thirds were reemployed by January 2016, nearly half of the reemployed group suffered reductions in their wages. Manufacturing workers made up about 17% of the long-term displaced group.

In principle, apprenticeship can reduce or contribute to displacement associated with technical change. Unlike school-based programmes to develop skills, apprenticeship ensures a close match between current and expected future demands by employers and the content of education and training. Apprentices learn on the most modern machines and learn the principles underlying their

occupational tasks. Since most technological changes are evolutionary, well-trained apprentice graduates can use their conceptual and practical skills to adjust to and sometimes even promote technological change. Evidence from Germany suggests that apprentices experience training that is broad enough to transfer their skills across a wide range of occupations and that over two-thirds of former apprentices (including those who changed jobs) report using 'many' or 'very many' of the skills they learned as apprentices (Clark and Fahr, 2001). Alternatively, others argue (Hanushek et al, 2011) that those trained through apprenticeship will have limited mobility as their skills become outdated.

In the U.S., an array of small scale programs has been undertaken to deal with the implications of technical change for the workforce. The National Science Foundation sponsors industry-school collaborations to improve the education in such high technology fields as cybersecurity (National Science Foundation, 2017). One is the Florida Advanced Technological Education Centre that developed an Engineering Technology Associate Degree, which sponsors two-year degree programs in engineering technicians. The Kentucky Federation of Advanced Manufacturing Education is sponsoring an advanced manufacturing learning pathway model in Louisville, Kentucky. But these and other programs affect only a modest share of the workforce.

The main government-funded programmes for training or retraining workers to prepare for specific careers are postsecondary college programs with a technical/occupational focus and the federally-funded, locally delivered workforce programs under the Workforce Innovation and Opportunity Act (WIOA). Funds and regulatory authority come from the federal government, but WIOA is administered through state and local workforce boards, headed by business leaders, labour representatives, and state and local government officials. These boards must submit plans and reports to the U.S. Department of Labour. Although the WIOA programs offer information and job placement services to about 5 million workers, only about 200,000 received occupational training (Besharov, 2017).

Several other federal training programmes, including Job Corps, YouthBuild, and Trade Adjustment Assistance, offer training to an additional 80,000 workers. A larger source of career-focused education and training is the system of community and private career colleges. Although the data on these colleges are incomplete, they cover a very high share of colleges. In 2015, 6.8 million students enrolled in public two-year colleges and another 351,000 enrolled in private two-year colleges (National Center for Education Statistics, 2017). If we count enrolment in less than two year programmes, the total number jumps to almost 12 million as of 2011-2012. Over 60% of these students in these colleges are taking occupational courses. However, those taking manufacturing-related programmes represent only about 6% of students. On the other hand, students in these majors represent about 5% of the number employed in manufacturing.

Overview of the apprenticeship system

Definition of apprenticeship

The provision of apprenticeships in the US largely corresponds, to the Cedefop definition:

> *'systematic, long-term training alternating periods at the workplace and in an educational institution or training centre, which leads to a qualification. An apprentice is contractually linked to the employer and receives remuneration (wage). An employer assumes responsibility for the company-based part of the programme'.*
>
> (Cedefop, 2015)

Apprenticeships in the United States combine structured, in-depth work-based learning with classroom instruction leading to an occupational certification. While this definition is widely accepted, differences arise when one considers the U.S. legal and regulatory framework for apprenticeship. Specifically, apprenticeships fall into registered and unregistered categories. The registered apprenticeship system involves government oversight and regulation, though minimal funding. Apprentices have contracts with employers and receive progressive wage increases as the apprenticeships proceed, usually over three to four years. Some companies undertake apprenticeships that include structured programmes combining work-based learning, academic instruction, and productive work yielding occupational skills, but do not register their programme with a government entity.

Apprenticeships differ from most other VET pathways in at least four ways. First, apprentices spend most of their time and learn occupational skills mostly at the workplaces, not in school settings. Second, apprentices contribute directly to production, thereby lowering the social costs of training and the apprenticeship sponsor's costs of subsidizing training. Third, apprentices benefit from the close attention of mentor/supervisors. Rarely are there more than four apprentices per mentor, in sharp contrast to school-based setting where mentoring and advising are minimal. Fourth, apprentices are likely to transition seamlessly into skilled positions in employers where they undertook their apprenticeships.

Regulatory framework and institutional context

Regulation of apprenticeships in the U.S. dates to 1911, when Wisconsin created the first registered apprenticeship system. Other states passed similar legislation, but it was not until 1937 when the Congress passed the Fitzgerald Act aimed at protecting labour standards and to safeguard the welfare of apprentices. The Act specifically called on the federal department of labour to cooperate with states. In 2008, the U.S. Department of Labour issued new regulations governing the apprenticeship system that allowed for interim credentials and competency-based occupational standards, provided for provisional registration, and encouraged increased cooperation with publicly-sponsored workforce training programs (Employment and Training Administration, 2017).

The federal government allows states to establish apprenticeship agencies and undertake the registration process. In 26 states, sponsors of apprenticeship programmes request registration from State Apprenticeship Agencies (SAAs). The federal government oversees the program in all other states. Some policymakers regard the current registration system that involves both states with SAAs and those subject to only the federal apprenticeship offices as in need of reform (Lerman, 2014).

A separate component of the registered apprenticeship system is the United Services Military Apprenticeship Programme (USMAP). Through this programme, the U.S. Coast Guard, Marine Corps, and Navy have become programme sponsors of registered apprenticeships in nearly 100 occupations (Hanson and Lerman, 2016). Although apprentices in USMAP undertake training that is similar to the training experienced by regular enlisted service members, completers of the specified work processes within each occupation receive a journey person certification from the U.S. Department of Labour in the relevant occupation.

Notwithstanding this governing law and regulations, registration of apprenticeships is not mandatory. As noted above, firms are free to create training programs with apprenticeship characteristics, call them apprenticeships, and not register with a government agency. Although there are no reliable national data on the number of genuine apprenticeships not registered with state or federal offices of apprenticeship, several companies create programs and hire workers to undertake a combination of work-based training and academic study toward occupational competence that amounts to an apprenticeship. Notable examples of such companies in the automobile manufacturing industry include BMW, Toyota, and Volkswagen.

Another set of examples outside the registered apprenticeship system is youth apprenticeship. Only a few states, notably Georgia and Wisconsin, now operate youth apprenticeship programmes that provide opportunities to 16 to 19-year-olds (Lerman, 2014). State funding pays for coordinators in local school systems and sometimes for required courses not offered in high schools. In Georgia, 143 of 195 school systems currently participate in the apprenticeship programme and serve a total of 6,776 students. These apprentices engage in at least 2,000 hours of work-based learning as well as 144 hours of related classroom instruction. The Wisconsin programme includes one- to two-year options for nearly 2,000 high school juniors or seniors, requiring from 450 to 900 hours in work-based learning and two to four related occupational courses. The program draws on industry skill standards and awards completers with a certificate of occupational proficiency in the relevant field. Some students also receive technical college academic credit. In Georgia, the industry sectors offering apprenticeships range from business, marketing, and information management to health and human services and technology and engineering. The Wisconsin youth apprenticeships are in food and natural resources, architecture and construction, finance, health sciences, tourism, information technology, distribution and logistics, and manufacturing[1].

Financing the apprenticeship system

Neither the federal nor state governments provide significant funding for the apprenticeship system. The federal budget allocates about $30 million per year to operate the Office of Apprenticeship (OA), a small sum for a U.S. labour force of over 150 million. OA uses the funding to oversee the registration process, to record information on apprentices, and to issue completion certificates. In addition, OA pays for field staff workers who are supposed to market apprenticeships, give tentative approval of proposed standards, and audit programme sponsors for compliance with regulations. Both the federal and state authorities overseeing the apprenticeship system are woefully understaffed. In some states, only one or two people provide the staffing for the apprenticeship programme in the entire state. According to the OA representative interviewed in the frame of this study, the number of full-time federal staff dropped by 40% from 173 to 116 between 2005 and 2014.

[1] For information on the occupational fields in the Wisconsin youth apprenticeship program, see the http://innovativeapprenticeship.org

Recently, the federal government allocated funds for specific, time-limited projects apprenticeship. In 2015, it awarded $175 million over five years in competitive grants to 46 organizations undertaking demonstration projects aimed especially at extending apprenticeship to occupations outside construction. In 2016, the U.S. Congress appropriated another $90 million for apprenticeships. With this funding, OA provided $50 million to help states stimulate more companies to adopt apprenticeship programmes and $20 million to intermediary organisations to expand apprenticeship and to widen access to apprenticeship to women and race/ethnic minorities.

Still, government funding for apprenticeship training remains marginal. Companies undertaking apprenticeships generally must finance not only the costs of the on-the-job training but also the costs of related academic instruction. Some states offer small tax credits and/or use federal funding for other workforce programmes, such as those financed under the Workforce Innovation and Opportunity Act (WIOA), to aid in the financing of apprenticeship. The result is that the costs to the employer of an apprentice are far higher than for employers in most other countries.

Key actors involved and their governance role

The OA and SAAs try to encourage employers to develop programmes and hire apprentices, register acceptable apprenticeship programmes, supervise compliance with programme standards, and advise on apprenticeship programmes (Lerman, 2010). Unlike most countries, the U.S. system does not develop or mandate national or state occupational standards for apprenticeship. Instead, a program consists of a sponsor and an occupation. Typically, sponsors are individual firms, but some sponsors are unions or other entities that organise an occupational programme for several firms. Joint Apprenticeship Committees (JACs), in which employers and trade unions are each represented, are responsible for a substantial share of apprentices, mainly in the construction industry. For a new apprenticeship programme, sponsors submit documentation about how their programme will operate, including lists of competencies that apprentices are expected to learn and the hours of classroom or "related" instruction. The OA or relevant SAA may approve or not approve the plan. One result of this system is that training for a given occupation can follow several different occupational standards. In addition, approvals for registering an apprenticeship programme can vary widely, even for similar proposals, depending on how strict and restrictive are the practices that federal representatives or state agency boards implement.

Employers and union sponsors play central roles in financing apprenticeships and in selecting related instruction. In the case of JACs in construction, union workers and employers each contribute an amount per hour to finance training centres in the relevant occupation. Employers pay for the wages and the time of the trainer. The main role of community or career colleges is to offer courses that cover the theoretical subject matter required for competence in the occupation. Employers and other sponsors decide on the competencies apprentices learn, the duration of each learning module, and which organization delivers the theoretical instruction (often the employer or union itself). In short, the programmes operate mostly at the discretion of employers.

Major statistical data and trends

National data on the U.S. registered apprenticeship system reveal a good deal of pro-cyclical variation with only a modest trend. As shown in table 1, the total U.S. apprenticeships reached over 505,000 in 2016. Civilian (non-military) apprenticeships accounted for 410,000 of this total, a large increase over the 288,000 in 2012/2013 but only 20,000 more than in 2008 and nearly 60,000 less than in 2002 (United Stated Department of Labor 2017).

Table 1: Trends in Registered Apprenticeships, Totals and Percent of the US Labour Force

Year	Non-Military Apprenticeships	Military Apprenticeships	Total Apprenticeships	U.S Labor Force	Civilian Apprentices, % of US Labor Force
2008	390,741	51,645	442,386	154,321,583	0.25%
2009	361,488	58,652	420,140	154,188,500	0.23%
2010	317,850	69,870	387,720	153,885,250	0.21%
2011	295,288	62,404	357,692	153,623,667	0.19%
2012	288,375	73,748	362,123	154,973,833	0.19%
2013	287,750	87,675	375,425	155,395,417	0.19%
2014	314,923	95,452	410,375	155,906,417	0.20%
2015	352,159	95,770	447,929	157,128,167	0.22%
2016	410,370	95,001	505,371	159,186,417	0.26%

Source: U.S. Department of Labor, Employment and Training Administration, Office of Apprenticeship, 2017a

As a percent of the civilian labour force, civilian apprenticeships stood at nearly the same level, 0.26% in 2016 and 0.25% in 2008. Most of the large declines in apprenticeship during the 2008-2013 period and the large increases in apprenticeship since 2013 resulted from the ups and downs of the construction sector. Over 2008-2016 period, apprenticeships in the U.S. Military Apprenticeship Programme (USMAP), which takes place in the Coast Guard, Marine Corps, and Navy, nearly doubled from 51,000 to 95,000 (Hanson and Lerman, 2016). Today, the share of the U.S. labour force in apprenticeships is only about 1/10th the comparable share in such other English-speaking countries as Australia, Canada and England.

These figures exclude apprenticeships not registered with state or federal agencies. There is however no good estimate of the number of unregistered apprenticeships.

The U.S. apprenticeship system does not collect separate data on supply and demand. However, anecdotal evidence based on long waiting lists for many apprenticeships suggests that the supply of willing apprentices far outpaces the employer demand for apprenticeships. Apparently, apprenticeship sponsors have little trouble filling their slots, suggesting that the supply of potential apprentices is at last as high as the demand.

Data on the characteristics of apprentices are only partial because 19 states provide only aggregate data on their programmes. In 2016, of the 203,000 civilian apprentices in states governed by the federal office of apprenticeship, over 70% are in the construction industries. Manufacturing accounts for only about 7% of all apprenticeships and a tiny proportion of manufacturing employment (U.S. Department of Labour, Employment and Training Administration, Office of Apprenticeship, 2017b)

Although women make up less than 10% of U.S. apprenticeships, the main reason is the occupation and industry composition of apprenticeships. The minority share of apprentices is more than representative of their share of the workforce. For example, of those identified by ethnicity, Hispanic Americans make up about 30% of apprentices but only 26% of the overall labour force. African-Americans account for 13% of apprentices reporting a racial classification and about 12% of the U.S. labour force. (U.S. Department of Labour, Employment and Training Administration, Office of Apprenticeship, 2017b).

Key challenges

The U.S. apprenticeship system faces many challenges. It is underfunded; it is a very small share of the workforce; it is currently concentrated in a few industries; it has no good mechanism to market to individual employers; it lacks standards for trainers or a third party assessment system for apprentices; it lacks national occupational frameworks; it is governed by a complex and uneven mix of federal and state agencies; it is subject to many self-defeating policies geared to construction but not well-suited to other industries; and it is not well-known to employers, workers, schools, and parents.

The results are evident in the low penetration of apprenticeship. But the most important deficiencies that have limited the coverage and scale of apprenticeships are funding and marketing. Nearly every country with a robust (and some not so robust) apprenticeship system funds the off-job skill development of apprentices, mainly in classrooms. The U.S. system does not. This practice means that companies are forced to pay not only the wages of the apprentices and pay for the time costs of in-company trainers but also finance the off-job training. Marketing to individual firms is critical, especially for the registered system of apprenticeship, because of the lack of knowledge about apprenticeship among most U.S. companies and the complexities of building skill standards and registering the programme.

The most important challenge for the U.S. apprenticeship system is to stimulate employers to offer more apprenticeships. At current, relatively low levels of apprenticeship, the supply of workers wishing to undertake good quality apprentices well exceeds the demand for apprentices. An extreme example is the Newport News Shipyard owned by the Huntington-Ingalls company. The shipyard creates about 240 apprenticeship openings per year in their four year apprenticeship program in the Apprentice School. Apprentices begin working for the shipyard almost the day they enrol. The shipyard prepares workers in a variety of occupations. In its most recent year, the school/programme attracted more than 4,000 applications for the 240 apprentice positions. High quality building trade programmes report that the supply of applicants far exceeds the number of open apprentice positions (Newport News Shipyard 2017).

Although some favour appeals that persuade parents to become more receptive to apprenticeship models for their children, today's reality is that many apprenticeship positions attract several applicants. At the same time, some apprenticeship sponsors report having trouble attracting well-qualified students.

The rising demand for skill is a long-term trend that continues to influence the labour market and public education and training policies. According to a 2012 McKinsey Center for Government report, 45% of U.S. employers said a skills shortage is a leading reason for entry-level vacancies. Moreover, Cappelli (2012) argues that any skills shortage is the result of a decline and shortfall in employer-sponsored training.

The U.S. apprenticeship system devotes virtually no resources to developing occupational standards. Except for a recently funded project to create competency-based occupational standards for apprenticeship, the Office of Apprenticeship (OA) and state apprenticeship agencies approve or reject sponsor-specific proposals that include frameworks for what apprentices will learn. The lists of competencies are called 'work processes' in the registered apprenticeship system. There is no one approach to defining work processes. For many occupations, the apprenticeship offices have approved several programmes sponsored either by an individual employer, a trade union, or other entity associated with several employers of apprentices. Each programme has its own list of competencies and usually amounts of time apprentices are expected to spend on each. In 2008, OA issued a new regulation encouraging the use of competency as well as time-based standards and hybrid standards that combine competency and time-based listings (Employment and Training Administration, 2017).

In 2015, OA awarded Urban Institute a contract to create competency- and hybrid-based occupational frameworks for apprenticeships. Initially, the goal was to create 'safe harbour' occupational standards that would allow employers using the standards to register their programmes quickly. According to the interview with the OA representative, the project has developed several competency standards but the way they will be used remains uncertain. For the manufacturing sector, there are occupational frameworks under construction for industrial technology maintenance, tool and die worker, stamping press setup operator, and CNC set-up programmer.

Outside the apprenticeship world, states have a range of license requirements for occupations as diverse as physician or surgeon and hair stylist. These have no formal connection with apprenticeship. But, programmes are approved based on ensuring that apprentices gain sufficient skill over their apprenticeship to meet state licencing requirements.

The central challenges to expanding the U.S. apprenticeship system are the limiting marketing resources, the lack of funding for off-job training, and improved quality assurance and third-party assessment system. In the existing registered apprenticeship system, staffing is quite limited, with very few individuals assigned to marketing apprenticeships to individual firms. The level of employer knowledge is low concerning how to structure an apprenticeship and how apprenticeship can be a high return investment. Given the limited number of firms undertaking apprenticeship, there is little peer-to-peer learning. The political leadership of the federal and state governments rarely highlight the role of apprenticeship. The staff required to assure the quality of apprenticeship programmes is limited as well. Even the approval process for proposed occupational apprentice programmes is uneven. Finally, the system lacks a third-party assessment system to certify the skills of workers completing apprenticeships.

One particularly serious challenge is the broad acceptance of the role of community colleges in providing career and technical education. Public policies have long favoured this academic approach to career-focused skill development, providing large subsidies to public two-year programmes at community colleges. These schools enrol nearly 7 million students are often viewed as a suitable venue at which to gain job-ready skills. Community colleges and for-profit schools offer qualifications in quite detailed occupations, such as domestic air conditioner and furnace installer, medical receptionist, and medical coder. State and local governments support community colleges directly to keep tuition levels low. The federal government provides direct support to community college students (and four-year college students) as part of grant and subsidised loan programmes. When the U.S. experienced high unemployment rates in 2009-2013 periods, the federal government chose to use over $2 billion in discretionary dollars to support community college, career-oriented programmes for workers affected by trade.

Community colleges are increasingly collaborating with apprenticeship programmes, especially with the Labour Department's Registered Apprenticeship Community College (RACC) consortium. For example, in the Minnesota Advanced Manufacturing Partnership, South Central College in partnership with other 11 colleges, university and centres of excellence are developing relevant learning pathways in mechatronics, computer aided machining and welding. Still, apprenticeship remains a minor component for most community colleges. Moreover, the lack of support for apprenticeship in the U.S. is certainly linked partly to the assumption by policymakers and the public that community colleges and for-profit career colleges can meet the challenge of teaching marketable occupational skills to students.

Apprenticeship policy and practice in the manufacturing sector

Apprenticeship in the manufacturing sector

The manufacturing industry accounts for the largest number of apprentices after the construction industry and the U.S. military apprenticeship programme (USMAP). Unfortunately, precise figures on the number of manufacturing apprentices do not exist for two reasons. First, industry details on apprentices in the registered apprenticeship system are available only for 25 states overseen directly by the OA and a few others in state administered systems. Second, as noted above, the available data document the industries of only those in the registered apprenticeship system. There is an unknown but probably sizable number of apprenticeships not registered with the OA or state apprenticeship agencies.

The data at hand reveal that manufacturing apprentices account for only about 7% of all civilian apprentices. Projecting from the data on selected states to the entire nation, we can approximate the total number of registered apprentices in civilian manufacturing at about 29,000. Machinists are common in manufacturing facilities; they make up nearly 400,000 manufacturing positions. Yet, there are only about 3,000 or fewer apprentices in the field. Similarly, industrial maintenance, industrial mechanics, and millwrights account for about 460,000 manufacturing jobs, but the number of apprentices in these fields is approximately 5,000-6,000. Welding positions are widespread in manufacturing, with employment at about 850,000, yet the number of apprentices pursuing welding is probably no more than 2,000 (U.S. Bureau of Labor Statistics, 2017).

The scale of manufacturing VET pathways in colleges of two-years or less is over ten times the number of apprentices in manufacturing. As of the 2011-2012 academic year, enrolment of students in colleges of two years or less in the fields identified as manufacturing reached about 440,000. About 340,000 students participated in mechanic and repair occupations and another 100,000 in precision production fields.

In programmes of two years or less, post-secondary schools awarded about 120,000 certificates and 25,000 two-year degrees in manufacturing occupations in 2015. Students in mechanic and repair fields earned 83,000 certificates and about 20,000 two-year degrees. Precision production is the other major manufacturing profession listed among VET majors in community and career colleges (National Center for Education Statistics, 2017).

Given the absence of national standards, individual employers determine the apprentice occupations that emerge. The number of occupational profiles within the federally regulated system with at least one active apprentice is about 620. Additional profiles exist in state-regulated apprenticeships, though the exact number is difficult to determine because not all states list their profiles and because the OA does keep records of all profiles approved at the state level.

In several occupations, including some in manufacturing, the federal office of apprenticeship has registered more than one set of skill requirements. Each employer or union sponsor often develops and gains approval for their specific apprenticeship programme. Existing frameworks that specify occupational skill requirements (called ‘work processes’ in the language of the OA) vary widely. For example, one machinist registered apprenticeship programme presents only one page of work-based learning requirements, listing mostly numbers of hours the apprentice must spend on various machines, hydraulics, and pumps and valves. The related instruction page specifies eight courses the machinist apprentice must complete. Another machinist registered apprenticeship programme standard, one developed by the National Institute for Metalworking Skills (NIMS), is elaborate and detailed, with rich descriptions of the 28 core competencies, performance objectives, and performance standards. The detail is such that simply describing the standards and the related instruction takes 35 pages, with clarifying text on each performance

object and performance standard and with listings of NIMS credentials machinists will be able to complete and with specifications of which examinations are required.

Currently, the occupational profiles of registered apprenticeships are housed at the OA but not easily accessible to companies and workforce professionals who may wish to promote apprenticeships. One reason is that for some companies, skill profiles are proprietary and not in the public domain. Furthermore, skill standards of registered apprenticeships approved at the state level are not transparent and many are not compiled at the federal level.

Strengths and weaknesses of the system

The U.S. system of registered apprenticeship is currently not particularly appealing to companies. Firms complain about the paper work required to gain approval as a registered apprenticeship sponsor, about the cost of and time to develop their own occupational profiles and skill standards, and about the perception that firms sponsoring apprenticeship will be subject to additional regulatory burdens. Another perceptual barrier is the belief by some firms that the apprenticeship system is so heavily dominated by unions that firms offering apprenticeships expose themselves to a higher risk of unionization. There is no evidence that firms are more subject to becoming unionised if they adopt apprenticeships. However, most apprentices are in unionised programmes, while most apprenticeship sponsors are non-union firms. Another problem is that, except in states that offer small tax credits and other modest incentives for apprenticeships, firms routinely receive no funding for the work-based or school-based components of apprenticeship.

Still, apprenticeships are attractive mechanisms for firms who want to make sure they have enough skilled workers to perform well in their business activities. Evidence from surveys of more than 900 employers indicates that the overwhelming majority believe their programmes are valuable and involve net gains (Lerman, Eyster, and Chambers, 2009). Nearly all sponsors reported that the apprenticeship programme helps them meet their skill demands - 87% reported they would strongly recommend registered apprenticeships; an additional 11% recommended apprenticeships with some reservations. Other benefits of apprenticeships include reliably documenting appropriate skills, raising worker productivity, increasing worker morale, and reducing safety problems.

The distinction between registered apprenticeships and other types of apprenticeships is important to consider. Many manufacturing companies choose to put together training programmes in which workers learn skills at the workplace as well as in courses, typically community college courses. They may choose to register their programmes but few find any great advantage in doing so.

Matching supply and demand mostly takes place informally. Companies or union programmes announce openings, screen candidates, and then select apprentices without any formal government or even private matching system. For most apprenticeship programmes, the number of applicants far exceeds the number of apprenticeship openings.

There are no independent measures of quality of apprenticeships. Occasional audits take place but once an apprenticeship sponsor is approved, the programme nearly always continues without an external quality assessment. One indicator of quality is the earnings returns to workers who take part in apprenticeships. Evidence from a few studies indicates that workers who enter and complete apprenticeships achieve significant gains in earnings. Their long-term earnings benefits exceed the gains they would have accumulated after graduating from community college (Washington State Workforce Training and Education Coordinating Board, 2015). A broad study of apprenticeship in 10 U.S. states also documents large and statistically significant earnings gains from participating in apprenticeship (Reed et al, 2011).

As noted above, recent actions by the U.S. Congress have provided the registered apprenticeship system with an added $90 and $95 million in funding in Fiscal Years 2016 and 2017. So far, the funds have helped to increase the system's ability to modernise, adjust and involve new industry associations, such as the National Restaurant Association and the Illinois Manufacturing Association. Among the steps taken by OA are improving its website, developing a tool-kit for employers, creating sectors of excellence in apprenticeship (SEAs), funding the creation of competency-based occupational frameworks for apprenticeship, and making new efforts to engage groups of employers in promoting apprenticeship. The 2014 reauthorisation of the workforce system under WIOA provides encouragement for funding apprenticeships but so far only the stimulus to apprenticeship is limited, as reported by the OA representative interviewed in the frame of this study.

Key requirements arising from technological and other changes in manufacturing

Technical change is increasing the skill requirements of manufacturing occupations. The interaction of electrical and mechanical trades has set off a large demand for mechatronics apprenticeships. Continuing moves toward digitisation is increasing skill requirements in many professions and expanding the demand for information technology workers. However, because of the lack of national occupational frameworks for apprenticeship, it is difficult to detect in the many company-based programmes actual adjustments in the content or curricula of manufacturing apprenticeships. To stimulate apprenticeships in occupations outside construction, in late 2015, the U.S. Department of Labour awarded $175 million over five years to 46 grantees as part of the American Apprenticeship Initiative (AAI). The evaluation of the AAI grants is set to include a return on investment study in selected sites. One target is to increase the number of apprentices in advanced manufacturing. While currently manufacturing accounts for only about 7% of registered apprentices, 65% of the 46 grants under the AAI are targeting manufacturing, including such production occupations as assembly and fabrication, metal and plastic working, and plant and system operation. The grantees are diverse, ranging from state agencies to community colleges to local non-profit organizations. One relevant example is the grant to the Illinois Advanced Apprenticeship Consortium (IAAC). Maintenance apprenticeships on advanced equipment are among the primary occupations sponsored by IACC.

One broad initiative stimulated by Labour Department grants is the creation of the Industrial Manufacturing Technician Apprenticeship (IMT) (AFL-CIO, 2017). Several organizations, including labour unions and workforce intermediaries, collaborated to create this new apprenticeship framework. It is an 18-month or 3,000-hour apprenticeship that trains workers of all ages to set up, operate, monitor, and control production equipment; to improve manufacturing processes and schedules to meet customer requirements; to understand manufacturing as a business system that integrates multiple disciplines, processes, and stakeholders; and to manage time and materials efficiently and safely. The IMT apprenticeship framework reflects the increasing skill demands in manufacturing. The number of apprenticeship sponsors and apprenticeships that will be generated under the IMT is not yet clear.

Another set of new standards are being developed by the National Institute for Metalworking Skills (NIMS) with support from industry and the U.S. Department of Labour. These include elaborate apprenticeship frameworks for becoming a Certified Machinist, Toolmaker, or one of several types of CNC Setup Programmers.

As noted above, the Registered Apprenticeship Community College consortium (RACC) (U. S. Department of Labour, 2017) is an effort to link apprenticeships with two-year college programmes. The goals include providing apprentices with accelerated pathways to earn an associate's or bachelor's degree. Often, courses at community college are not part of mainstream

degree programmes. Under the RACC initiative, colleges agree to provide credit for registered apprenticeship completion certificates. It is unclear the extent to which this initiative will raise the level of skills achieved through apprenticeships.

Virtually no U.S. apprenticeship programmes are affiliated with four-year, BA programmes. One notable exception is the bachelor's degree programme involving a partnership between Old Dominion University and Newport News Shipbuilding. Students at Old Dominion University, for example, now can do a four- to eight-year stint as apprentices at a nearby shipyard while simultaneously earning a bachelor's degree in mechanical or electrical engineering. The apprentices spend a day or two per week in the classroom and the rest of their workweek on the job at Newport News Shipbuilding. Old Dominion's apprenticeship began in 2013. The programme is quite expensive to companies, working out to at least $225,000 paid for wages, tuition, fees, textbooks, and a benefits package (Fain, 2015).

Advanced manufacturing: mapping reform processes and adjustments

The nation's formal Vocational Education and Training systems—now called Career and Technical Education (CTE) — have generally not integrated well with apprenticeship. Federal funding under the Perkins Act provides over $1 billion to states for supporting their CTE programmes, both at the high school and the postsecondary levels (Perkins Collaborative Resource Network, 2017). But, these funds make up a small share of federal grants and a small share of state and local expenses on primary and secondary school education. States vary widely in their financing of CTE programmes at the high school and post-secondary levels. It is common for states to provide high school programmes a payment based on the number of full-time equivalent students (FTEs) enrolled in CTE programmes. Most vocational programmes at high schools and community colleges have industry advisory committees, but the linkages between schools and employers are uneven. One exception is the Apprenticeship 2000 effort in North Carolina, where a set of companies and schools worked closely to develop high quality, manufacturing apprenticeships (Adenberger, 2013).

In the late 1980s and early 1990s, certain researchers and advocates began an effort to inform and influence policymakers about the advantages of incorporating formal apprenticeships into a revamped vocational education system. Commissions published national reports highlighting the weaknesses in the U.S. school-to-work (STW) and their negative impact on the career outcomes of young people not bound for college.[2] In response, the first Bush administration sponsored youth-apprenticeship demonstration projects and proposed the National Youth Apprenticeship Act of 1992 but Congress did not act on this proposal. Separately, school-to-work initiatives were also developing at state and local levels—in Oregon, Wisconsin, and Arkansas, and in Boston, Rochester, and Tulsa, Oklahoma. In 1994, the Clinton administration proposed and the Congress enacted the School-to-Work Opportunities Act (STWOA) with large majorities in both houses. The law allocated funding mainly to states so they could create the institutions and reforms. However, by the time the bill became law, youth apprenticeship was downplayed as a major intervention. No serious coordination between vocational education and apprenticeship materialized overall in the U.S. (Lerman, 2013).

A few states, notably Wisconsin, Georgia, and Maine, did attach high priority to youth apprenticeships. In Wisconsin, state agencies, collaborating with industry and labour groups, developed about 23 skill standards in fields ranging from the printing and automotive industries

[2] See the Commission on the Skills of the American Workforce and Commission (1990) and the Commission on Youth and America's Future (1988).

to biotechnology and finance. The standards require high-level competencies achieved at the workplace as well as related academic instruction, often delivered through technical colleges. In Wisconsin, students choose apprenticeships beginning in 11th grade (about age 17). The Wisconsin programme has remained small in percentage terms but serves as a good example of integrating high school CTE programmes and apprenticeships (Lerman, 2014).

In the 1990s, several sector partnerships emerged in selected cities under the leadership of labour market intermediaries to gain expertise on skill requirements of local employers in specific sectors and to build sequences of training and job opportunities for less advantaged individuals (Pindus et. al, 2004). Sector partnerships organize multiple employers in an industry cluster, unions and local organisations working with less advantaged workers, and local government representatives into a working group that focuses on the shared goals and human resources needs of such industry clusters as health care, plastics manufacturing, biopharmaceutical manufacturing, and information technology. The 2014 reauthorization of the Workforce Investment Act included an emphasis on sectoral strategies. Under WIOA, state plans must describe how employers will be engaged—including through industry sector partnerships. Local workforce boards (typically stand-alone units created to administer federal grants and overseen by boards made up of business, labour representatives, and government) must use adult and dislocated worker funds to develop, convene, or implement sector partnerships, and state support for local sector partnerships is an appropriate activity. Such plans could target manufacturing though only a small share target apprenticeships.

Several initiatives are pursuing apprenticeship practices that are innovative in the U.S. context. Longstanding youth apprenticeship programmes in Wisconsin and Georgia provide a range of opportunities in manufacturing. Wisconsin's youth apprenticeship programme boasts occupational areas such as engineering, machining, maintenance, installation and repair, and bioscience. The Governor of Colorado is attempting to replicate aspects of the vaunted Swiss apprenticeship system, by youth apprenticeships in late high school that involve a combination of work-based learning, paid work and production, and classroom learning. Some manufacturers have developed apprentice-style training programmes that include the key components of apprenticeship but do not register their programme with the Department of Labor. Among the more innovative programmes are the Toyota manufacturing apprenticeship programme in Kentucky, the Kentucky FAME programme, the ThyssenKrupp programme in Illinois, and the fast-growing youth apprenticeship programme in South Carolina. The FAME programme, is patterned after the Toyota training system (Kentucky Federation for Advanced Manufacturing Education, 2016). Once students are accepted into programme, they begin working on a combination education/training programme to earn certification as an Advanced Manufacturing Technician (AMT). They attend classes at a local community college two days a week and work 24 hours a week for a local employer – all while being paid a competitive wage. After five semesters, students will earn an associate degree in Applied Science in Industrial Maintenance Technology-Advanced Manufacturing Technician Track, two years of work experience and the AMT certification.

During most of the Obama Administration, the emphasis in career-focused education and training was on expanding community colleges. But in 2015, it launched the American Apprenticeship Initiative (AAI) with grants totalling $175 million over five years to 46 grantees.[3] Many focus on

[3] This initiative fulfilled a commitment to the American Manufacturing Partnership set up by the Obama Administration to 'grow the talent pipeline'. More information is available at https://obamawhitehouse.archives.gov/blog/2014/10/28/accelerating-advanced-manufacturing-america

information technology and health, but 30 of the 46 grantees working with advanced manufacturing. The grantees include state agencies, local workforce boards, community colleges, Chambers of Commerce, unions, industry groups, and non-profit workforce organizations. One grant emphasizing manufacturing went to the Illinois Advanced Apprenticeship Consortium in concert with the German-American Chamber of Commerce. It aims to create 600 apprenticeships in such occupations as industrial maintenance, CNC operators, and secure software developers. Another is the West Central Job Partnership involving organizations in Ohio and Pennsylvania, which aims at creating apprenticeships in machining and CNC programming. The success of these efforts is uncertain as of mid-2017.

The Trump Administration committed to apprenticeship expansion in its first year and proposed doubling the funding for apprenticeship to $200 million. A Presidential Executive Order called for creating 'industry-recognised' apprenticeships as a way of simplifying the systems for approving apprentices and for the creation of a task force to examine strategies to encourage the private sector to create apprenticeships (Lerman, 2017). It is however unclear whether these initiatives will generate large numbers of apprenticeships in manufacturing and other industries.

Commentary and conclusion

Notwithstanding the progress in U.S. apprenticeship and the recent innovations, the U.S. faces many challenges and barriers to creating a high quality and viable apprenticeship system. However, the shortfall in high skill manufacturing workers (Deloitte and Manufacturing Institute, 2015) and the weaknesses of existing systems in training them are becoming widely appreciated enough to generate action in overcoming the barriers.

Perhaps the most important barrier is the perception that community colleges, career colleges, and four-year colleges are sufficient to generate the skills required for the labour market. This perception helps drive the allocation of government spending and policy initiatives, with funding reaching about $400 billion per year for about 20 million students. Teaching the skills required for manufacturing technical careers is generally viewed as the job of community colleges. Unfortunately, few students major in these subjects and the dropout rates from community colleges are high. Of degree-seeking students in community colleges (public two-year colleges), only 22% graduate within three years. For African-American students, the percent graduating within three years was only 11.6% (National Center for Education Statistics, 2017). Moreover, interviews with selected manufacturers find even those that graduate as lacking the hands-on skills required for many skilled positions. By contrast, about 50% of non-military apprentices complete their apprenticeships (Reed et al, 2011).

Still, the consensus on the need, even urgency, for improving career preparation is beginning to take shape. More government leaders and workforce experts are seeing the potential gains in moving from today's academic, school-based approach to a work-based strategy involving apprenticeship. Nonetheless, recasting career preparation from college programmes to apprenticeships will take time, despite their much higher social and personal returns than most college programmes.

Several barriers have slowed the expansion of apprenticeship in the U.S. One is the absence of government financing for key functions of an apprenticeship system. Unlike other countries, there is no routine government funding for the off-job course and academic instruction embedded in apprenticeship. Most U.S. employers have very limited knowledge about apprenticeships, how they work, and how to set them up. Yet, there is little government support for marketing apprenticeships to companies. Developing and updating occupational frameworks are important functions for any apprenticeship system. The U.S. lacks a source of funding for creating these frameworks and updating them.

A second set of barriers relates to regulating and overseeing apprenticeships. The process of 'registering' an apprenticeship programme can be exceedingly cumbersome. To gain approval to register one occupational programme from an individual employer sponsor or group of sponsors, the sponsors must submit extensive sets of forms that specify the 'work processes' or skill standards as well as assurances that the programme will meet equal opportunity requirements and in many cases, have an adequate ratio of journey-persons (experts or prior apprenticeship graduates) to apprentices. One source of complexity is that the federal office of apprenticeship has delegated the process for registering programmes to state apprenticeship agencies in about half of all states. Some of these agencies are quite restrictive in which apprenticeship applications they will accept for registration and some require high ratios of journey-persons or other experts to apprentices. Even in the states in which the federal office maintains authority to register programmes, the registration process is uneven, with some federal representatives approving applications quickly and others taking many months to approve applications for registration. Instead of the current uneven and cumbersome registration process, the U.S. could adopt the approach of other countries by having well-publicised and well-researched occupational

frameworks that inform companies about the skills apprentices are expected to learn and that allow for speedy registration.

The absence of national or even regional occupational frameworks does offer prospective employer sponsors a great deal of flexibility in the way they structure their programmes. However, this flexibility comes at the cost of uncertainty and frequent delays in the registration process as well as reduced portability of the apprenticeship certifications.

Another challenge relates to the concentration of U.S. apprenticeships in commercial and industrial construction industries (builders of office buildings, malls, schools and factories) and in programmes sponsored by unions. Since about 70% of apprenticeships are in these industries, representatives from construction are often placed on state apprenticeship agency boards. In some cases, barriers arise because these agencies can create obstacles to registering apprenticeship programs in other industries that do not resemble construction apprenticeships in terms of duration and having high ratios of journey-persons/trainers to apprentices. A second challenge is overcoming the reputation of apprenticeships as primarily training for a building trade occupation. The result is that few workers or employers conceive of apprenticeships in sales, business, accounting, information technology, travel and tourism careers. Further, the concentration in construction is largely responsible for the gender imbalance; only about 7% of U.S. apprentices are women.

The weak linkage between apprenticeship programmes and high schools and colleges is another challenge. Little counselling takes place at the high school or two-year college level concerning apprenticeship opportunities. One result is that workers generally enter apprenticeships in their mid- to late-20s, after their earlier labour market experiences have been unsatisfactory. With workers starting apprentices at this age, there is pressure to pay apprentices higher wages than would be the case had young people started apprenticeships in their teenage years.

In general, U.S. apprenticeship programmes are oversubscribed, with some having long waiting lists for workers to get into the programmes. However, many apprenticeship applicants lack sufficient academic or employability skills to enter many apprenticeships. Even among those able to enter apprenticeships, only about 50% of apprentices complete their programmes (Reed et al 2011). Still, this completion rate far exceeds completion rates for two-year college career preparation programmes. The weak skill of many potential applicants bodes ill for the future of apprenticeship. Currently, there are sufficient qualified candidates wanting to enter apprenticeships; but if the system expands significantly, the problem of too few qualified candidates may become far more serious.

The U.S. may be ready to embrace a substantially increased role for apprenticeship in preparing potential workers for careers. The weakness and high costs of other systems, especially in their ability to prepare workers well for a range of careers that do not require a BA degree, are becoming increasingly evident. U.S. policymakers and researchers increasing see the success of countries with robust apprenticeship programmes in maintaining high youth employment, smoothing the transition from school to careers, and meeting industry requirements for skilled workers.

While the U.S. has many advantages for manufacturing, including low energy costs and room for economies of scale, U.S. and foreign manufacturing firms often report that their inability to find skilled workers constrains their expansion in the U.S. It is the very skilled workers for whom apprenticeships are especially suitable.

Notwithstanding the clear case for apprenticeship expansion, it will take sustained efforts of political leaders and business managers to develop and sustain an array of new policies and orientations on the part of employers and workers to achieve the proportion of the workforce in

apprenticeships found in other market-oriented, English-speaking countries (including Australia, Canada and the UK).

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Annex 1: Glossary

Abbreviation	Term/ explication
AMT	Advanced Manufacturing Technician
CNC	Computerized Numerical Control
CTE	Career and Technical Education
FTEs	Full-time equivalent students
GDP	Gross domestic product
JAC	Joint Apprenticeship Committee
IMT	Industrial Manufacturing Technician Apprenticeship
MEP	Manufacturing Extension Program
NIMS	National Institute for Metalworking Skills
OA	Office of Apprenticeship
RACC	Registered Apprenticeship College Consortium
SAA	State Apprenticeship Agency
STW	School-to-work
STWOA	School-to-Work Opportunities Act
US	United States
USMAP	United Services Military Apprenticeship Program
VET	Vocational education and training
WIOA	Workforce Innovation and Opportunity Act

Annex 2: List of consulted national stakeholders and experts

Type of organisation	Name of organisation	Position
Ministry responsible for VET but not apprenticeship	Department of Education	Former Deputy Assistant Secretary, Office of Vocational and Adult Education
Employer organisation	National Association of Manufacturers	VP, Strategic Initiatives, Manufacturing Institute
Trade union organisation	United Auto Workers	Coordinator, National Joint Apprenticeship Committee
VET expert /research institute	Office of Apprenticeship	Regional Director, Office of Apprenticeship

The European Foundation for the Improvement of Living and Working Conditions (Eurofound) is a tripartite European Union Agency, whose role is to provide knowledge in the area of social, employment and work-related policies. Eurofound was established in 1975 by Council Regulation (EEC) No. 1365/75, to contribute to the planning and design of better living and working conditions in Europe.