Skills Gap or Training Gap?

The Role of Manufacturing in Solving the Skills Gap Problem

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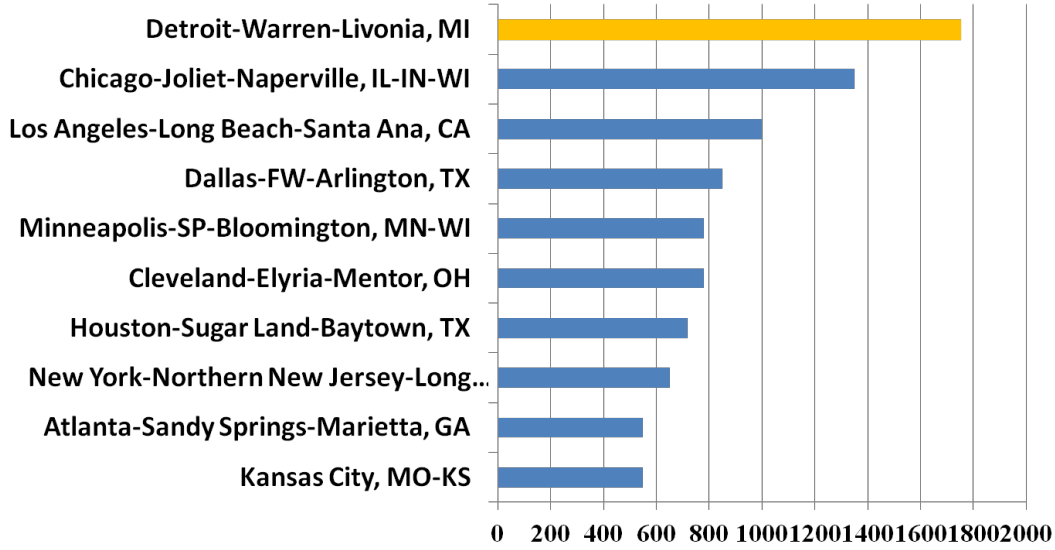
INTRODUCTION: The Manufacturing Skills Problem

In the twenty-first century, manufacturing continues to be fundamental to Michigan's (MI) economic prosperity, export intensity, and long-term innovative capacity. Yet manufacturers across the state are said to be experiencing a debilitating skills gap and talent shortage, which is a microcosm of a pervasive problem throughout the U.S. In the wake of the worst economic downturn since the Great Depression, and with unemployment currently at 7.3 percent, an ongoing mismatch supposedly persists between the skills and technical knowledge that producer firms in MI and throughout the U.S. demand, on the one hand, and what the labor market is able to supply, on the other.

On one side of the debate, a 2011 survey of over 1,100 CEOs from producer firms across the country, conducted by Deloitte and the Manufacturing Institute, found that over two thirds of manufacturers (67%) are experiencing a moderate to severe shortage of qualified workers, with over half (56%) anticipating the problem will continue to get worse in the coming years. Moreover, companies reported having the hardest time filling skilled occupations that are critical to competitive advantage, with 5% of jobs continuing to go unfilled due to lack of qualified candidates. In fact, a lack of available skilled production workers, such as machinists, operators, technicians, and programmers, has had a significant negative impact on the productivity and market performance of nearly three quarters of survey respondents (74%) (Deloitte, 2011). Yet on the other side of the argument, new research by the Boston Consulting Group (2012) shows that the skills problem is not as significant as the above data indicates, that it is not a nationwide phenomenon, but rather, highly localized, reflecting imbalances driven by location and job class.

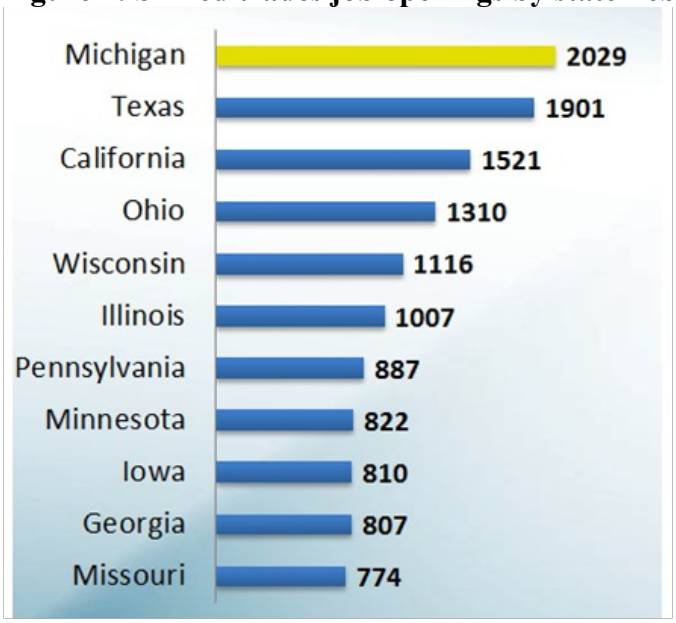
When one hones in on regional variations, Michigan consistently comes out on top in skilled manufacturing positions that are going unfilled. For one, demand for skilled employees is high in Michigan. Research by the Workforce Development Agency (WDA) has shown that production jobs in the state, which make up to 53% of the manufacturing labor force, advanced by 6,800 jobs between 2011 and 2013. When replacement positions are factored in, manufacturers provided over 8,800 annual job openings in production alone, with positions in the manufacturing sector growing faster than average across all occupations through to 2013 (Pure MI Workforce Development Agency, 2013). In one specific occupational category, for instance, CNC machinist demand is higher in Detroit-Warren-Livonia than in any other MSA in the country between January and September 2012 (Figure 1). In another example, skilled trade job openings topped all other states from February to May 2012, with over 2000 skilled workers needed in MI, over a hundred more than Texas, and well ahead of California and other U.S. manufacturing regions (Figure 2). These findings indicate not only the sheer scope and severity of the skills problem in the U.S. industrial heartland of Michigan, but also the disturbing consequences that the ongoing disparity in labor demand and supply has had on firm performance and regional economic growth.

Figure 1: Top 10 MSAs with CNC machinist demand Jan.-Sept. 2012



Source: Burning Glass Technologies, via WDA

Figure 2: Skilled trades job openings by state Feb.-May 2012



Source: Burning Glass Technologies, via WDA

This co-learning plan provides a deep understanding of the skill challenges that local producers in MI face, the factors that shape these challenges, how the increased technological intensity of manufacturing work has had a bearing on skill requirements, and the implications of these shifts for training strategies, both inside the firm, and training provision by local educational institutions. It also provides a list of best practices that have been adopted by manufacturing firms and their innovation partners, in MI and abroad, in order to successfully address skill shortages while meeting long-term community and industry needs.

This report proceeds over six sections. It begins with a summary of the research methods for data collection and then proceeds to address the following specific questions: Why is it so crucial that we address the manufacturing skills problem? Why have skills become so important to competitiveness in the contemporary economy? How did we get here, in other words, what are some of the causal factors that have led to the present skills mismatch? Where do we go now, that is to say, how do we bridge the gap? By way of conclusion, this report provides a summary of key findings.

A NOTE ON METHODS

In order to address the above questions, this co-learning plan draws on a variety of information sources, encompassing both primary and secondary forms of evidence. In addition to a review of policy, academic and popular literatures, use is made of original case study research, which involves a series of in-depth, semi-structured interviews with, and consultation by, private sector actors and a network of national, state, regional and community stakeholders. In addition, preliminary research was conducted on the training practices of globally competitive manufacturing firms in a niche industry in MI: companies that produce plastic molding machines (to manufacture thermoformed end products) and advanced CNC (computer numerical control) equipment for the processing of wood panels, solid wood, composites, glass, stone and other materials. A total of three private sector machinery firms were surveyed to assess their recruitment, training, retention and labor management practices.

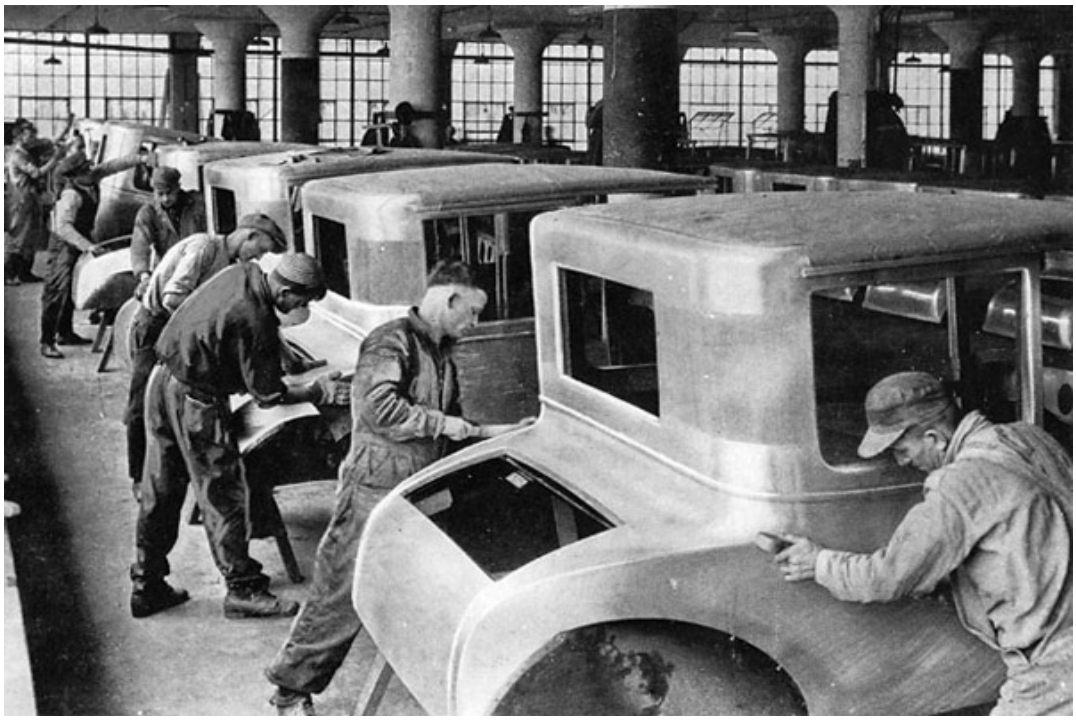
This research of firm practice was supplemented by interviews with representatives from the Michigan Manufacturers Association (MMA), the Michigan Economic Develop Corporation Workforce Development Agency (MEDC WDA), the Michigan Manufacturing Technology Center (MMTC), the National Association of Manufacturing (NAM), representatives from local economic development corporations, industry associations, local community colleges and vocational education institutions, Michigan State University departments and other intermediaries (see Appendix I for a list of interview participants and Appendices II-III for survey instruments). This work has also been supplemented by the author's own multi-year, mixed-methods study of the institutional foundations of innovation in the high-end corporate furniture sector in Canada, which underwent dramatic growth following the advent of North American free trade beginning in the late 1980s.

When one weights this combination of data, the research that is presented here provides an extremely useful window on the nature and extent of the manufacturing skills problem in Michigan and throughout the U.S. today. As well, it proposes practical, on-the-ground, sustainable solutions that can assist firms and their stakeholder partners to address workforce development obstacles in their communities.

WHY IS IT SO CRUCIAL THAT WE ADDRESS THE SKILLS PROBLEM?

Manufacturing in Michigan Matters

Manufacturing is embedded in Michigan's history and national consciousness, and a strong manufacturing base has been fundamental to its economic success. The auto industry's mass production methods, originally invented in Michigan, were the core of 20th century industrial development, and Henry Ford's revolutionary wages attracted workers from across the U.S. and the world to work on his state-of-the-art production lines. Despite significant job losses throughout the years, the sector still employs 10% of the state's workforce, and over half a million workers in the production of automobiles and their parts, metals, machinery, food, furniture, plastics, bioscience, and a myriad of other goods that are exported to global markets. In fact, manufacturing constitutes 30% of MI's economic production, more than twice that of any other sector, and the bulk of research and development (R&D) in the state's economy.[i] As well, small and mid-sized manufacturing companies (SMEs) are the foundation of vibrant communities, with the industry contributing more than $1.5 billion annually toward educational, cultural, human services and other community-building efforts (Michigan Manufacturers Association, 2013). Indeed, manufacturing remains of vital importance to MI's innovative capacity, export-intensity, and economic growth, constituting a crucial source of high wage jobs, particularly for non-college educated workers.



Many manufacturing jobs are capital-intensive production activities, and thus tend to generate higher productivity per employee than those in other sectors. Consequently, wages are higher than average, which has a direct impact on the quality of life enjoyed by Michigan workers and

their families. For example, manufacturing workers are said to have made 37% more income than their counterparts in other private sectors in 2011 (Pure Michigan Workforce Development Agency, 2013). According to the Michigan Manufacturer Association (MMA), this translates into a wage premium of nearly $25,000 per year, and an annual average salary of $76,124 per production worker. At the U.S. national scale, research shows that workers earned an 8.4% premium over non-manufacturing employees in 2012 (Helper, Krueger and Wial, 2012). Moreover, manufacturing has been shown to have the largest multiplier effect of any industry in the economy, with each new job added creating four to six indirect jobs in other industries. Manufacturing companies in MI today are productive, high value-added businesses that generate more output with fewer workers. While this has meant steady job loss over the decades, as indicated, the jobs that remain in MI require more skills and often pay disproportionately higher salaries than those of an earlier era.[ii]

The Skills Gap Could Derail a U.S. Manufacturing Resurgence

In a recent survey, 61% of 287 U.S. manufacturing firms reported that they are considering shifting their production closer to their North American customer base (Ferreira and Heilala, 2011), and anecdotal evidence has revealed that several companies, including Caterpillar, GE and Ford, have begun to 're-shore' operations due to increasing production and energy costs associated with overseas production. For instance, Caterpillar has repatriated manufacturing of construction excavators, boosting investment in facilities in Texas, Arkansas and Illinois (Figure 3). Siemens has also moved a major transportation vehicle production facility to the Sacramento region. Is this perhaps a microcosm of a promising trend playing out in the U.S. manufacturing industry, whereby major multi-national corporations are deciding to bring some of their previously off-shored supply chains and production networks from places like China back to the U.S.? Indeed, many scholars and policymakers are beginning to wonder if the off-shoring trend that has plagued much of the U.S. industry over the past decades is beginning to reverse itself. When one considers the changing set of conditions in the global economy, as well as shifting economics in U.S. labor markets, these patterns are not that surprising.

For one, wages between the U.S. and China are converging, and as of 2010, Chinese productivity remained less than a third of that of the U.S. (Sirkin, Zinser and Hohner, 2011). In fact, Chinese wages increased on average 19% between 2005 and 2010 (Brookings 2012), and are projected to continue in this direction in the coming years. What used to be a 30% Chinese cost advantage has now dwindled to no more than 6%, at the same time that wages in the U.S. have stagnated. Second, long supply chains in Asia add cost, time, and risk, and considerably reduce flexibility to serve customers in North America and Europe. As one key informant has pointed out:

> *The tsunami in Japan raised the visibility of a number of the risks of having an extended supply chain. So those companies that may make final assembly here but source things from overseas are now starting to source more things in the U.S. And there is every indication that that will continue for the next several years.* Interviewee, Manufacturing Institute

This is a particularly critical issue in sectors that are dependent on a just-in-time (JIT) operating model, and where quality concerns and time-to market are important determinants of competitive advantage. Quality problems are simply harder to solve due to geographic and cultural distance, and separation between design, engineering and production is shown to constrain long-term innovative capacity (Hatch, 2013). These factors are combined with what has been a boom in U.S.-based energy production that is seeing the cost of energy and natural gas reduced significantly in the U.S. compared to overseas (Christopherson, 2011).

Figure 3: A U.S. manufacturing resurgence?

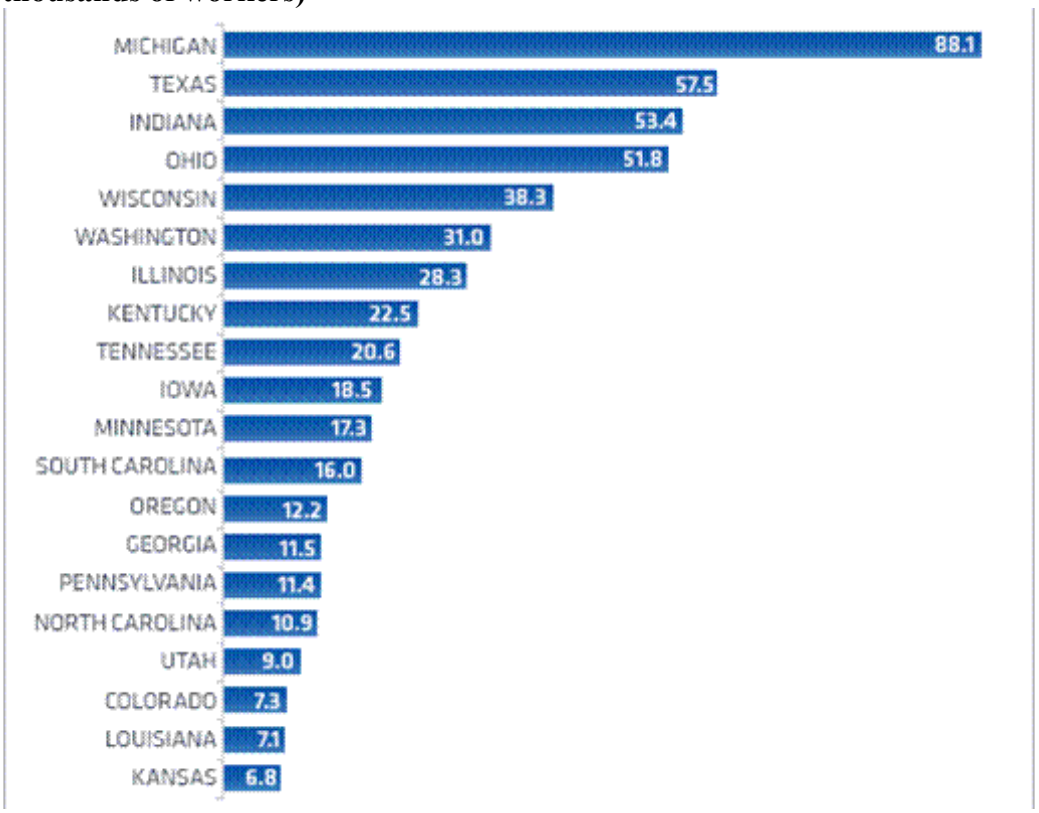
Outsourcing Shifts Into Reverse: Caterpillar Brings Productio Back from Japan = +1,000 New Jobs

Mark J. Perry | November 12, 2011, 12:48 am

Wall Street Journal — "Caterpillar said it plans to shift production of small construction machinery from Japan to a new plant in North America that is expected to employ more than 1,000 people. The new plant, whose location wasn't identified, will become the company's global source for small bulldozers and mini-hydraulic excavators. It also will export partially

Of course, the factors that might incentivize a return to the U.S. will undoubtedly vary by firm and industry. For instance, intellectual property (IP) leakage is an increasingly important determinant of where a company chooses to invest in new manufacturing capacity. Industries that rely significantly on IP are drawn to the more robust regulatory protection that the U.S. offers after experiencing the challenge of piracy elsewhere. Other firms in capital-intensive sectors may seek proximity and access to cutting edge U.S. automation and robotics technology.

Figure 4: Top 20 states for manufacturing job creation (Dec 2009 to March 2013) (in thousands of workers)



Source: National Manufacturers Association

Not surprisingly, the re-shoring trend is resulting in a stronger demand for skilled and qualified manufacturing workers in the U.S., and studies have shown that Michigan ranks highest of all states in creating the most manufacturing jobs (Figure 1). For example, between December 2009 and March 2013, the National Association of Manufacturers has shown that Michigan created over 88,000 jobs, far exceeding manufacturing employment in other states (Figure 4). This puts MI considerably ahead of its closest rival, Texas, by over 30,000 positions during this period, and well beyond other manufacturing regions in the Mid-West like Indiana and Ohio by nearly 35,000 jobs. This data shows that manufacturers and their regional partners in MI are at a critical juncture. On the one hand, this report has shown that MI is creating more manufacturing employment than any other state, yet on the other, it is also struggling more than other places to find skilled workers to fill those jobs.

WHY ARE SKILLS SO IMPORTANT?

Shifts in the Nature of Contemporary Competition

While manufacturing remains vital to Michigan's economic foundation and long-term innovative capacity, the nature of competition affecting producers in most industrialized economies has undergone widespread changes in structure and orientation since Henry Ford's automobile age (known, duly, as 'Fordism'). The precise contours of these shifts, and the forces producing such change, have been the subject of a flurry of discussion and debate within geography and across the social sciences. As scholars have argued since the mid-1980s, a substantial shift in the nature of contemporary capitalism has emerged (Piore and Sabel, 1984; Scott, 1988; Best, 1990; Sayer and Walker, 1992; Amin and Thrift, 1992; Storper, 1997; Cooke and Morgan, 1998). With stagnation in the growth of aggregate demand, mass markets previously served by a limited range of standardized products have been transformed into smaller, more fragmented and quickly changing niche markets. In other words, an older competitive regime, in which firms sought to expand their market share by lowering their prices, and sought to lower prices primarily by expanding production to achieve economies of scale, has been replaced by new competitive realities. Considerable attention has since been drawn to the development of new production and innovation practices in a period characterized variously as 'post-Fordism', after-Fordism', the 'new economy', the 'creative economy', the 'knowledge-based economy' or the 'learning economy'.

These broader shifts have resulted in fundamental changes in the supply side of the economy, as manufacturing firms have sought new ways to gain market share by tailoring their products towards qualitatively distinctive market niches, and pursuing a competitive strategy based on factors such as design, quality and distinctiveness, rather than cost alone (Scott, 1988; Scott, 2001; Power and Scott, 2004). Moreover, the onus on firms to achieve successful innovations in product and process has become paramount. In pursuing smaller, more fragmented and quickly changing niche markets, firms have recognized that responsiveness to changing market conditions and on-time delivery are critical determinants of success in many industries. In response to these competitive pressures, manufacturers have also been compelled to adopt radically new sets of practices and forms of organization in the workplace.

For starters, it has become clear within the contemporary period of capitalism and intensified globalization that knowledge, learning and innovation are vital elements for economic development and growth, and the capability to create and diffuse knowledge (also referred to as innovation) is therefore a key economic process that strongly influences national and regional economic performance. By extension, a firm's ability to combine new and existing types of economic knowledge, at a greater number of interfaces, both within and outside the firm, is a much more fundamental and strategic process than it was before, and central to economic change and growth (Lundvall and Johnson, 1994). In order to access an increasingly complex and variegated knowledge base, it has become imperative for firms to open horizontal communications at all levels of the organization, as well as develop cooperative relations and alliances with external actors. This has entailed a growing need for a much broader participation in the learning process, and therefore the development and multi-skilling of individual workers, as well as a strategy in which firms are able to harness the specialized knowledge of their workers to create innovative products and processes. Firms have also been compelled to implement advanced manufacturing technologies (AMT) and novel approaches to workplace organization that enable flexibility, responsiveness, and quality improvements, or risk extinction (Gertler, 2004).

Closely related to these internal changes has been a restructuring in the wider social division of labor between firms, in effect, an expansion of the locus of innovation from the internal resources of the firm towards external networks and knowledge pools (Sayer and Walker, 1992; Cooke and Morgan, 1993; Saxenian, 1994). Under these competitive conditions, it has proven far more efficient for a producer to draw upon the specialized inputs of external suppliers in order to achieve its competitive goals more effectively. In fact, one of the central features of intensified globalization and integration of world markets has been the redefining of the core competencies of the firm to focus on the highest value-added segments of manufacturing and service, while

reducing direct ownership over non-core functions. This has laid the groundwork for changes in the governance structure of firms in sectors producing for global markets - towards vertical disintegration - as producers find it advantageous to outsource an increasing share of their non-core activities (Gereffi et al., 2005). As such, larger producers, called original equipment manufacturers (OEMs), have downsized and outsourced many functions and inputs to smaller establishments, many of them constituting supply chains to the OEMs. Thus, discrete elements of the production process that were once provided within the boundaries of the legal entity of the firm are increasingly being acquired through market transactions between firms and external suppliers. Thus, the same principles of specialization and division of labor operating inside the firm are now being exploited at a social scale of organization between firms, which has enhanced the overall flexibility of producers, both individually and collectively, rendering geographical proximity between innovation partners increasingly important.

At the same time, however, this shift towards vertical disintegration has severely reduced the training capacity of individual firms, since most U.S. manufacturing now consists of lead producers that depend on networks of specialized suppliers that provide components and help with innovation. Consequently, individual producers, on their own, may no longer be able to develop entry-level candidates through an in-house system of advancement and job rotation to the extent they once did.

The Nature of Manufacturing Work

Prior to addressing the pressing skills disparity, it is useful to consider the very nature of skill development in the manufacturing process, and in particular, its place- and time-specificity. Research in geography and industrial dynamics shows that unlike scientific, theoretical knowledge, which can be easily transferred into codes understandable by others, important parts of industrial knowledge remain tacit (Gertler, 2001). In other words, they are highly context-specific and practice-oriented, and therefore cannot be easily removed from their industrial and social contexts (Asheim and Gertler, 2001). For this reason, an essential aspect of learning and skill development must happen outside the college classroom and directly on the plant floor, rendering the manufacturing firm a central site for training provision. According to the National Association of Manufacturers (NAM), effective hands-on learning programs are critical to helping students understand the knowledge behind technology and its application to real-world environments and situations. In any effective training program, students should therefore have access to programs that integrate rigorous curriculum and learning criteria with real-world scenarios, on-the-job training, and apprenticeship programs (National Association of Manufacturers, 2013).

Another reason why critical parts of training need to happen at the workplace relates to the team-oriented, interactive and collaborative nature of the manufacturing innovation process. Research shows that innovation and skill development depend largely on incremental developments and trial-and-error type problem-solving. Such a process is dependent upon the expertise of multi-disciplinary teams consisting of mechanical and electrical engineers, designers, machinists, production workers and their supervisors, marketers, and so on. As well, the messy reality of manufacturing practice involves both success and failure, the latter probably occurring more

frequently than the former, and as equally valuable as a source for innovation. In the words of an engineering practitioner,

> *We construct and operate... systems based on prior experiences, and we innovate in them by open-loop feedback. That is, we look at the system and ask ourselves `how can we do it better?' We then make some change, and see if our expectation of `better' is fulfilled'* (Kline, 1995, page 63).

Logically, this group-based, interactive process has to happen at the manufacturing workplace environment.

There is an important time factor as well. Learning and innovation rest on the ability of workers and interactive teams to build a wealth of problem-solving capability through many years of training (via learning-by-doing). Of fundamental importance is the ability of workers to develop a high level of expertise through consensus-based, interactive working relations that are cultivated through stable employment relations, and over the long-term. This means that full-time permanent employment structures are more conducive than those of temporary projects to the learning and innovation process in industrial settings.

Much like the nature of contemporary capitalism itself, the knowledge requirements in the manufacturing industry have undergone significant evolution and change. Whereas historically, the industry has been reliant upon distinct occupational skills sets (i.e. a handful of electricians, a handful of mechanical technicians dealing with computers and logic controls, and so on), in the last five to fifteen years, there has been a greater expectation of an integration and a blending of skills. Manufacturers are also expecting employees in so-called traditional manufacturing

occupations like welding or machining to work with the assistance of computers. In other words, they are not welding by hand, but rather programming the machines or the robots to perform the welding. Thus the combination of increases in automation and the rapid enhancement of computer-aided technology within the manufacturing process have meant that production-level technicians on the plant floor, not engineers, are expected to be able to program, run and maintain the machinery and technology. These shifts have widespread implications for the way in which skill development and training is carried out. Technology's increasing impact has continuously raised employers' demands for more intelligent, well-educated, career-ready workers.

HOW DID WE GET HERE? SKILLS GAP CAUSAL FACTORS

Employment Decline and the Image Problem

The effect of massive layoffs starting in the steel industry in the 1970s, continuing through the off-shoring phenomenon of the 1990s and the most recent round of layoffs in the Great Recession has, not surprisingly, had a profoundly negative impact on the image of manufacturing. While the sector employed 25% of the U.S. workforce in 1970, that shrank to a mere 10% by 2005.[iii] This persistent employment decline over a period of decades culminated in the 2009 bankruptcies and government bail-outs of major giants in the automobile industry: Chrysler and General Motors (Figure 5). The deterioration of the automobile industry led to a loss of close to half of Michigan's manufacturing jobs—Detroit alone lost 150,000 auto industry jobs between 2000 and 2008. In the best case scenario, skilled workers who became laid off eventually retrained and transitioned to other sectors of the economy, or simply migrated elsewhere in search of economic opportunities. More commonly, however, this decline has resulted in poverty and devastation in manufacturing communities across MI.

> *"Moms and dads, grandmas and grandpas worked in those dirty stinkin' factories and lost their jobs and then they said 'we don't want that for our kids!'"*
> Interviewee, MI Workforce Development Agency

Not surprisingly, manufacturing suffers from a bad public image, as people were led to rationally conclude over the years that it is a neither stable nor safe career path. According to one interviewee, the perception problem does not simply stem from dissatisfaction with wages and company loyalty, it's also a belief that manufacturing jobs are at risk and therefore not desirable to MI workers and their families. Although a majority of Americans consider manufacturing important, research shows that less than 20% think there is a future in manufacturing, or would encourage their children to enter manufacturing-related fields (Deloitte, 2011).

Figure 5: Decline in MI manufacturing industry

GM bankruptcy will devastate communities

By Tom Eley
2 June 2009

In conjunction with its Monday bankruptcy filing, General Motors announced that it will shutter nine more plants and place three others on indefinite suspension. GM will also break contracts with more than 2,100 auto dealerships. The closings and layoffs were dictated and worked out in their detail by the Obama White House and its Auto Task Force.

The Pontiac Truck and Bus plant—one of the six Michigan GM plants slated for closure

This stigma has led to a decrease in student enrollment in and demand for technical programs, which has resulted in a dramatic reduction in training infrastructure at the K12 and post-secondary levels. Consequently, there is a smaller pipeline of students interested in entering the field. Moreover, workers are retiring at a much faster rate than they are being replaced, which means that companies are going to lose a large portion of their seasoned, skilled workforce in the next five to ten years.

Economic development in emerging economies is also shaping the skills crisis in the U.S., as research by Gordon (2012) points out. According to this view, U.S. businesses can no longer rely on engineers, scientists and other highly skilled talent from India and China to fill their skills gaps, as these sought-after workers are increasingly being attracted by opportunities in their native countries. He suggests that "a major war for talent" is now under way as Chinese tech manufacturers and Indian IT firms seek skilled workers. This has serious implications for a U.S. business community historically over-dependent on importing skilled people from abroad.

At the same time, the skills required of manufacturing employees at home continue to increase and get more complex, and the number of people who possess those skills are simply not keeping pace with the number of jobs required, particularly as multi-national corporations continue to re-shore manufacturing capacity back to the U.S.

Skills, Tenure and Training Conundrum in the U.S. Industrial Workplace

Introduction

The current skills shortage in MI and the U.S. is also shaped by the structure of U.S. capital markets, which creates a disincentive for producer firms to invest in the long-term development of their workers. Industrial practices that underpin manufacturing innovation are shaped by a set of nationally-anchored institutions that define the fundamental incentive structure guiding firm behavior. This insight constitutes one of the core ideas that has emerged from the institutional economic geography literature, in particular national business systems and 'varieties of capitalism' (i.e. Aoki, 1988; Gertler 1995, 2001, 2004; Pauly and Reich, 1997; Lam 2000, 2002; Hall and Soskice, 2001; Christopherson, 2002; Clark and Wojcik, 2007). As Lam (2000, 2002) argues, specific macro level institutional configurations and organizational forms promote different micro level labor market practices and paths of career development. For example, capital market institutions are said to shape time horizons and expectations concerning paybacks from investment. Likewise, labor market and industrial relations institutions determine the strength of incentives for firms to provide training, rates of labor force turnover, and other complementary practices such as the degree of participation of shop floor workers in firm decision-making.

This theory suggests that the U.S. economy presents regulatory obstacles towards the achievement of a high performance industrial workplace because it does not support a high-skilled model of innovation. Such a model is dependent upon an emphasis on workforce development and stable labor markets that provide the optimal conditions for employers' investments in training. Yet market governance regimes and labor market institutions in the U.S. are said to engender a very different set of conditions: unstable employment practices and a disincentive on the part of firms to train their employees (Hall and Soskice, 2001; Christopherson, 2002). This suggests that there is a gap in manufacturing practice in the U.S. that may be understood as an incompatibility between the need for a high-skill, long-term strategy, on the one hand, and a national regulatory framework and educational system that does not support this strategy, on the other.

How the U.S. Economy Compares to the Manufacturing Powerhouses of Germany and Japan: A Comparative Analysis of Skills, Training and Tenure

Yet the prevailing structure in the U.S., this theory contends, is one typical of other Anglo-American, liberal market economies (LME), such as the UK and Canada, whereby short-term investment regimes and labor market institutions engender unstable employment relations (Hall and Soskice, 2001; Christopherson, 2002; Gertler, 2004) (Figure 6). Despite the obvious links between labor force development and firm performance, the importance of training in the U.S.

and other LMEs tends to be undervalued, and firms maintain much shorter-term relations with their workers. The situation in the U.S. can be contrasted with the coordinated market economy (CME) in countries such as Germany, the Nordic countries, and Japan. Here, market governance regimes and industrial relations institutions are said to produce more long-term, stable employment relations beneficial to manufacturing innovation, a flattening of organizational hierarchies to enhance the empowerment of shop floor workers and the internal flow of information, and a strong propensity for firms to invest in the development of their workers (Hall and Soskice, 2001; Christopherson, 2002; Bathelt and Gertler, 2005). This theory claims the establishment of institutionally mediated forms of comparative advantage, as is evident in the global dominance of certain Continental European and Asian countries in engineering and complex manufacturing, Germany and Japan being the iconic examples. For instance, Japan is home to six of the top ten largest vehicle manufacturers in the world, including Toyota, Honda, Nissan, Suzuki an Mazda, and Germany is the world's second largest exporter (after China) (Rattner, 2011), dominating the higher-end luxury mid-sized auto market with corporations like BMW, Volkswagen Group, and Daimler AG.

Figure 6: Comparison between CMEs and LMEs (skills, training, retention, work organization)

Coordinated Market Economies (CME) i.e. Germany, Nordic countries, Japan	**Liberal Market Economy (LME) - Anglo-American countries i.e. US, UK, Canada**
Skills, Training, Retention/Turnover	
high-skill system resulting from apprenticeship training	training more sporadic, haphazard
internal labor markets and skills embedded in the firm	market-driven skills development ,skills acquired by the individual
greater propensity for firms to invest in skills of workforce, promotes long-termism	greater disincentive for firms to invest in labor force skills due to free-riding problem, chronic underinvestment of skills, promotes turnover
long-termism reinforced by wage-regulating institutions, unions, work councils	short termism reinforced by hire/fire strategies, acceptance of exit as necessary to upward mobility
strong social benefits/welfare to foster company loyalty and promote long termism	liberal welfare state and low levels of benefits promote mobility
Work organization	
hierarchical, rigid job categories	flatter org structure, fewer demarcations, team-oriented
worker representation in strategic decisions and innovation via work councils	worker representation enabled by flatter org structure, consensual management, informality

In the typical liberal market, Anglo-American economy such as the U.S., investment patterns, production organization and labor dynamics are significantly different from those that have been identified in the model manufacturing, CME regime. Firms in the U.S. are said to be more reliant on competitive market mechanisms to coordinate their activities, and are embedded in short-term

investment regimes and financial structures that are sensitive to current earnings and share prices on equity markets. As a result, they tend to emphasize individual rather than collective success, short-term financial gains, and are better able to foster emerging new industries through radical rather than incremental innovation processes. The more permissive institutional environment associated with the liberal market variety is said to facilitate a high degree of turnover among the labor force, the acceptance of exit as necessary to upward mobility, and reconfiguration of new knowledge and skills within flexible forms of organization to support risky entrepreneurial activities (Hall and Soskice, 2001; Christopherson, 2002).

Moreover, there is an endemic free-rider problem that exists in these economies, which means that competitive firms are able to buy workers in other companies out with higher wages and benefits. This creates a strong disincentive for firms to invest in the development and training of their staff, because as long as workers have the choice to move around, companies will be concerned about the loss of their skilled workers to their competitors, which creates a chronic undersupply of skilled workers. Moreover, firms are likely to emphasize workplace-specific skills over general skills in order to internalize their training investment returns, discourage poaching, and the increasing bargaining power of workers (Streeck, 1989). Thus a reliance on market-led strategies often means that local labor markets in these economies are incapable of meeting the demand of firms, especially in periods of rapid employment expansion and economic growth. Such economies are characterized by a lower level of trade unionism and a more liberal welfare and low social security standards, conditions which further reinforce mobility in the labor force.

In the critical area of job training and the acquisition of skills, employers in the U.S. tend to rely heavily on the external skills market, in other words, educational preparation and experience prior to employment, than do firms in CME countries. Lam (2000, 2002) refers to these as *occupational* labor markets, in which knowledge and learning are embedded in an inter-firm career rather than within a single organization, and therefore largely developed outside the organization. Here, formal education and training play a greater role than on-the-job training. As a result, knowledge and skills are embodied in the individual rather than the organization, and are personal properties for career advancement (which is why the loss of key individuals is a much bigger problem in Anglo-American countries like the U.S. compared with coordinated economies). Learning tends to be more person-centered and market-oriented, and rooted in the individual's profession and career strategy, which enables firms to align their knowledge base closely with shifting market requirements and technological changes (Christopherson, 2002). Authority is concentrated more at top management, making it easier for firms to release labor to respond to market demands, further reinforcing this pattern of employee fluidity. In the face of global competition, LME firms are more likely to move activities abroad to secure cheaper labor, and to pressure governments for deregulation (Hall and Soskice, 2001).

By contrast, coordinated market economies such as Germany and Japan tend to involve higher levels of state intervention than their liberal market counterparts. Firms in these countries depend more on collaborative relations between economic actors to coordinate their endeavors, emphasizing collective success, consensus and long-term concerns. Here, institutions are said to encourage long-term employment and business relationships, enabling firms to retain a skilled workforce over time, and underpinning distinct organizational competencies conducive to continuous, incremental innovation. Stable employment relations are reinforced by industry-

based wage regulation, which discourages the free-rider problem, and encourages employers to invest in upgrading employees through training. Under such conditions, workers are considerably more likely to commit themselves to achieving high-quality production outcomes. Strong social welfare policies encourage company loyalty among workers, and unions remain paramount (Bathelt and Gertler, 2005).

In these high-skilled economies, the system for educating and training workers is of obvious importance in imparting both industry-specific and firm-specific skills. Within the manufacturing sector in Germany, for example, the 'dual' structure of this system arises through the pairing of industry-based formal education programs with firm-specific training that is achieved through lengthy apprenticeships. This dual system ensures that workers will learn skills that are of direct relevance to the firm and enables graduates to find work at other firms within the same industry if the firms with which they apprenticed cannot offer them permanent jobs. These *internal labor markets* and skill development inside the firm are characterized by long-term employment tenures, oftentimes with a single employer, and incremental career progression through the ranks. On the German 'model manufacturing' industrial workplace, Bathelt and Gertler (2005, 2) contend that "-a complex set of complementary institutions have produced a national system that is premised on high skills in the workforce, high productivity, high wages, and a competitive model based on quality and high performance characteristics."

Education and Training Systems: 'Narrow Elitism' Versus 'Broad-Based Egalitarianism'

On the education and training dimension, national economies can vary according to the relative importance they ascribe to different types of knowledge (i.e. formal academic knowledge versus hands-on, practical skills), and the distribution of competence among the entire workforce. Lam (2002) shows that a narrow and elitist system is characterized by the dominance of formal academic knowledge and a highly uneven two-tier distribution of competence: a well-developed higher education system for the elite while the majority of the workforce is poorly trained. For example, the system in the U.S. and the UK can be described as 'elitist'. It displays a strong bias towards academic education and attaches minimal social status and credibility to practical skills, which act as a disincentive for investment in this area. As a result, there is a widespread lack of formal intermediate skills and qualifications among the general workforce in these countries. The wide disparity in the educational backgrounds and skill levels reinforces the domination of formal knowledge over tacit skills.

In contrast, a broad-based education and training system recognizes the value of both academic education and vocational training and is characterized by a widespread and rigorous general and vocational education for a wide spectrum of the workforce. A more even distribution of competence among the workforce provides a better basis for interactive learning and the cultivation of tacit knowledge as a source of organizational capability. Lam (2002) says that the cases of Germany, Japan and Denmark are illustrative. The systems in these countries accord relatively high social status to 'practical experience', and recognize it as a source of competence and qualification. This encourages investment in vocational training which has resulted in a good supply of intermediate skills.

WHERE DO WE GO FROM HERE? BRIDGING THE SKILLS GAP

Introduction

This co-learning plan has pointed out that manufacturing companies across Michigan and the U.S. supposedly cannot find the types of skilled workers that they are looking for, and that the skills disparity is constraining plant growth and economic development in communities and regions. The primary set of causal factors that has been discussed includes long-term economic decline in the manufacturing industry, a pervasive stigma about manufacturing careers, a loss of talent pipeline, an aging workforce, and a lack of training investments by firms. The skills problem is further intensified by an increased demand for tech savvy, multi-skilled, career-ready workers that is resulting from the re-shoring phenomenon in U.S. manufacturing. The final question at the heart of this report is this: where do we go from here? In other words, what are some viable solutions to the skills gap problem?

Figure 7: Best practices geared to specific stakeholder groups

Federal, state and local governments, schools and industry	**BUILD ALLIANCES BETWEEN INDUSTRY AND COLLEGES**
Federal and state governments, schools and industry	**EXPAND STEM EDUCATION (science, technology, engineering & math)**
Federal, states and local government, schools, economic and workforce developers	**CONDUCT OUTREACH TO ATTRACT / RETAIN TALENT**
Industry	**ADOPT A HIGH ROAD STRATEGY**

Despite an alleged widespread lack of available skilled human capital, many manufacturers have recognized the importance of not only collaborating with stakeholder partners to create skilled talent pools in their communities, but continually investing in the development of their workers in-house. In this vein, this co-learning plan focuses on four recommendations that are geared

towards specific stakeholder groups (Figure 7). These recommendations are: 1: Build alliances between industry and colleges (federal, state and local governments, schools and industry); 2: Expand STEM education (federal and state governments, schools and industry); 3: Conduct outreach to attract and retain manufacturing talent (federal, states and local government, schools, industry, economic and workforce developers); and 4: Adopt a 'high road' strategy (industry). In what follows, this report addresses each of these recommendations and the findings from the study, drawing on innovative best practice solutions to do so.

Best Practices

Build Alliances Between Industry and Colleges

The first recommendation, geared towards federal, state and local governments, schools and industry, is to build alliances between industry and colleges. Regional public-private partnership networks are emerging across North America from all segments of society in order to invest in the creation of talent pipelines able to support a globally competitive manufacturing industry. These business-education collaborations are oriented towards both short- and long-term goals, on the one hand linking unemployed individuals to vacant jobs via 'earn and learn' programs, on the other, revamping curricula from elementary school through to college. Financed by a combination of private sector investments, foundation grants and local, state and federal funding initiatives, these cluster partnerships have begun to successfully address skill shortages and in so doing, have helped to sustain and grow local economies (Gordon, 2012).

This co-learning plan discusses several of these alliance models that seek to create industry-led training programs that integrate students into the workplace and on the factory floor. In one case, a very strong public sector workforce development board is acting as an intermediary in organizing manufacturers and education providers and ensuring that that marriage happens. In other examples, private sector firms are working together to develop innovative solutions that might otherwise be difficult to tackle as an individual company. Solving problems on a multi-firm basis means that solutions are more likely to be of broad, long-term benefit to firms and workers throughout an industry or in multiple industries. In one particularly exciting model, a local community college is the driving force, interacting with educational partners and the regional school district to create industry-driven technical programs that help put local people to work in local industries. This co-learning plan draws on empirical examples that are deliberately diverse in terms of the nature of collaborative relations and the agents and actors involved in order to make the point that one size does not fit all; in other words, policymakers must be sensitive to industrial and geographical difference when devising college-industry alliance solutions for local workforce development.

- Kalamazoo Advanced Manufacturing Consortium
  http://grovescenter.kvcc.edu/business/amcc.php

The State of Michigan's Industry Cluster Approach (MICA) focuses on aligning efforts - initiatives, programs and funding - around five priority industry clusters, with manufacturing identified as one. This strategy, led by the Workforce Development Agency (WDA), is being

implemented in partnership with employers, the Michigan Works! System, the Michigan Economic Development Corporation (MEDC), local economic development entities, education and training providers, and statewide trade associations. A central activity of MICA is the convening of groups of employers to gather in-depth information about jobs in demand, skill gaps and training needs, allowing comprehensive dialogue, collaborative problem solving, and a more effective demand-driven workforce development system. The overarching objective is to adapt the workforce system in MI to produce more trainees with skills and competencies that align better with industry, and hence increase the likelihood of long-term employment upon the completion of training.

> *"A cluster-based workforce training system will train workers to fill actual jobs in the cluster and meet the actual skill needs of these jobs. This demand-driven approach stands in stark contrast to today's supply-driven training system, organized heavily by training providers."* Michael Porter, Harvard University

The State of MI has been highly instrumental in assisting manufacturers and economic developers in Kalamazoo to address the chronic skills shortage in the region. Several years ago, focus group meetings between area manufacturers revealed that there was a lack of qualified candidates to fill both entry-level and more advanced technical positions in the local manufacturing industry. The State of MI, through the Michigan Works! Agencies (MWA), played a critical convening role in bringing parties together, including employers, colleges and other key stakeholders, which led to the development of the Advanced Manufacturing Consortium in 2011. This public private partnership has worked effectively since its founding to attract, screen and train qualified candidates for manufacturing careers in local industries, considerably reducing skills gaps in the local industry while filling the long-term talent needs of area manufacturers.

> *"By trying to act as conveners, we go out there and try to bring those groups together. Because a lot of the time it's not just organically grown, and it doesn't happen unless there's some type of initiative going on."* Interviewee, WDA

> *"Many manufacturers don't know who's right next door to them, and how they can do shared products or services. It's a lack of understanding of who's around you, and how you can use those resources."* Interviewee, WDA

- Bluewater Wood Alliance (BWA) http://www.bluewaterwoodalliance.org/

In other examples, the impetus is coming from the manufacturing firms themselves. The Bluewater Wood Alliance (BWA) is a cluster of wood products manufacturing companies located in southwestern Ontario, and is a model for sectoral cluster organization that aims to solve training problems and confront other innovation-related issues that are common to member firms. It brings together over eighty companies in the advanced wood products industries for the purposes of joint projects in skills development as well as technology transfer, export development and experiences exchange. In the arena of training, the BWA works with community colleges, high schools and independent education providers in the region to set up a comprehensive skills development program that seeks to upgrade plant workers and pre-train new hires. The benefit to members is the ability to place workers into higher quality training programs (with cross-firm job rotation capabilities) at a lower cost than if individual companies attempt to provide training on their own. Although BWA is reliant upon funding at the federal, provincial and regional / municipal levels to support cluster activity, it is a grass-roots, membership-driven organization. In this example, industrial policy has played an indirect role to support cluster organization and to ensure that the BWA continues to work with the federal and provincial funding agencies to develop infrastructure and project funding. This includes working with educational institutions on the secondary and post-secondary levels to provide skills development for the industry. The cluster organization serves as an intermediary between government and the cluster, articulating the cluster's objectives and seeking funding to drive those needs forward. It also serves as a catalyst between and among the member firms, seeking consensus and articulating the needs, then organizing the means to satisfy them.

- Jackson Area Manufacturers Association http://www.jacksonjama.org/

Similar to the BWA, the Jackson Area Manufacturers Association (JAMA) is a non-profit association of manufacturers and associate members located in Jackson County, Michigan, and founded in 1937. JAMA promotes member collaboration to help develop solutions to address critical issues facing area manufacturers that might otherwise be difficult or impossible to tackle as a single company, in order to advance prosperity of its members and broader regional community. To that end, training and education have become a critical emphasis, as the need for a skilled workforce has come to the forefront in recent years.

When the local community college in Jackson decided to cut its manufacturing programs back in 2003 due to declining student enrollment, JAMA's member manufacturers immediately united with local education institutions, South Central MI Works!, the local workforce development board, and other regional partners with the goal to fill this gap and come up with a viable, long-term industry-led training strategy. Over the course of a year and a half, this collaboration led to the development of a comprehensive regional advanced manufacturing training program geared towards both post-secondary and K12 levels.

At I Can Make It!, JAMA adopts a Future Scientists of America (FSEA) project, "Tower of Babel," yet tailors it to focus more specifically on the development of advanced manufacturing literacy and knowledge. For instance, in the basic FSEA program, kids receive three different sized blocks: large, medium and small, with a dollar value attached to each, and they are tasked with building the tallest tower at the most inexpensive price. In JAMA's version, the kids get the blocks, as well as a digital micrometer and a set of blueprints. They then go through a quality control process where they measure each block using the tools provided in order to determine if they have any that don't meet the quality standards. Once they weed the bad blocks out, they then proceed to build the tower with the assistance of the blueprints, translating two-dimensional blueprints into a three-dimensional tower, and working within teams. Interviewee, JAMA

At the college level, the Academy for Manufacturing Careers is a skilled trades technical instruction (RIT) / Apprenticeship customized training program that is certified as a Registered Apprenticeship Program by the U.S. Department of Labor (with programs in tool & die, CNC machining, machine building, machine repair, industrial maintenance, welding, mold making, engineering technician). While learning valuable advanced manufacturing job skills, trainees also have options to earn college credits applicable to degrees from multiple post-secondary institutions, including Jackson College and Baker College of Jackson. The majority of courses are held at the Jackson Area Career Center, Richard E. Krohn Center for Excellence, and Lenawee Tech Center, which have up-to-date advanced machinery, equipment and technology that is equivalent to what is available in the industry.

The Academy also hosts an array of innovative K12 programming for young children such as *I Can Make It!* (Figure 8) and *Machining U* summer camps, and *Engineering is Elementary* for Kindergarten to second graders, which complement programs by area partners such as Junior Achievement, Shop Rat and the Great Start Collaborative to offer in-depth, hands-on STEM and advanced manufacturing learning programs.

Figure 8: JAMA's I Can Make It! Camp

- San Antonio Manufacturers http://www.sama-tx.org/

In yet another private sector alliance example, San Antonio Manufacturers recently partnered with the Alamo Community Colleges to introduce high-school juniors and seniors to manufacturing careers and higher education by completing an industry-driven curriculum to develop work ready skills in manufacturing. The dual-credit program incorporates classroom instruction with hands-on learning in a state-of-the-art facility and allows participating students to graduate high school with up to 35 credits, a National Career Readiness Certificate (NCRC), and the Production Technician Certification from the Manufacturing Skills Standards Council (MSSC). Local manufacturers provided significant input into program design and curriculum and local industry groups offer job internships valued as high as $2,800. The San Antonio manufacturers also recruit Academy graduates for job opportunities in their facilities in manufacturing production operations and facilities maintenance (Deloitte 2011).

- Mid-Michigan Community College http://www.midmich.edu/

In another model, a local community college with campuses located in Harrison and Mount Pleasant, Michigan - Mid MI Community College (MMCC) - is the driving force, working with Ferris State University (FSU) and the regional school district to create industry-driven training programs that support labor needs in the local plastics industry. The college has played an important role as convener of regional stakeholders to address workforce development obstacles in the regions of Arenac, Clare, Gladwin and Midland, which is the center of plastics and plastics machinery manufacturing in MI, a $23.1 billion dollar industry in 2009. The college began convening focus groups back in 2007 to explore factors that could potentially inhibit manufacturing growth when it recognized that the workforce necessary to sustain the plastics industry had been eroded over the years by outmigration, a lack of qualified new entrants and an aging workforce. In collaboration with the Clare-Gladwin Regional Educational Service District and FSU, it raised over $700,000 from the National Science Foundation (NSF) to support the creation of a Plastics Technology program on its Harrison campus. The NSF funding promotes learning in STEM fields and provides training in the plastics industry through a laddered approach, meaning that students are able to pursue non-credit training, academic certificates, or an associate's degree that will seamlessly integrate with FSU's Bachelor's in Plastics Technology program. The overarching goal of the grant is threefold: 1 - to deepen the college's partnerships with area manufacturers through an industry alliance in order to leverage alternative funding sources; 2 - to develop short term and robust training programs that are specifically designed around local employer's training needs and employment opportunities; and 3 - to recruit and retain students through comprehensive information and experiential opportunities related to careers in the plastics industry.

> *"We've always worked with our manufacturers, so it's easy for us to bring them around the table as a group and say 'what do you want?'"* Interviewee, Mid-MI Community College

> *"The list of manufacturing partners is quite extensive. These are active folks sitting on the boards from the machine builders to the thermo formers to the supply chain seal manufacturers, raw material components, plastic sheet extruders. I mean it's soup to nuts in this industry, and it is very exciting to see that."* Interviewee, Mid-MI Community College

Expand STEM (Science, Technology, Engineering and Math) Education

The second recommendation, targeted at federal and state governments, schools and industry, is to expand STEM education, which entails a number of considerations. First, STEM programs should start early. Research shows that children undergo an important stage of intellectual development and begin to connect theory with practice between the 4th and 6th grades, which is crucial for STEM learning. As well, they make important personal connections with their environment at that stage that can have a long lasting impact on their interests and eventual career choice. Therefore exposure to and participation in STEM programming starting at the primary level, rather than waiting until high school, is critical to the success of STEM education planning.

The Jackson Area Manufacturers Association's innovative programming for young children has been very successful. JAMA began focusing its efforts on the development of camps for young children, utilizing curriculum available from the Future Scientists and Engineers of America (FSEA), yet modifying content with an emphasis on advanced manufacturing principles, and delivering it in a traditional summer camp format. The first of its kind, "I Can Make It!" (Figure 8) is a week-long overnight camp at the lake where 4th to 6th graders are transported through time at the outset, with groups separated into the preindustrial, industrial/pre-computer, and contemporary ages upon arrival, and for the duration of the week. From there, children learn through a hands-on, experiential format about technology available to them in their time period, with their overall goal to adapt that technology (i.e. in the preindustrial period, that would include things like windmills, compasses, boats etc.) in order to survive the camp. They also learn how to design and make products over the course of the week.

As the camp format became increasingly popular, JAMA worked with its regional partners to expand its program offerings and "fill the talent pipeline," adding a wide array of innovative programs for youth of all ages. These include "*Machining U*," a more advanced summer camp for 12-14 year olds which introduces children to sophisticated techniques and processes such as CAD design, machining, welding, laser cutting and programming, and "*Engineering is Elementary*," geared towards fostering engineering and technological literacy in children from as early as kindergarten through to fifth grade.

The second goal is that K12 programs should emphasize team-based, experiential and interdisciplinary learning geared towards problem solving, and oriented towards work in production-related fields.

The third main consideration for successful STEM programming relates to curricula at the secondary level. Colleges and their regional partners need to ensure that both technical and academic STEM programming be integrated across universities and community colleges. For instance, Mid-Michigan Community College incorporates a laddered approach which gives students the option to transfer college credit to Ferris State University's BSC in Plastics Technology Engineering, if they wish. Similarly, JAMA's Academy of Manufacturing Careers skilled trades programs enable trainees to earn college credits that are applicable to degrees from multiple post-secondary institutions, including Jackson College and Baker College of Jackson.

Conduct Outreach to Attract and Retain Skilled Manufacturing Talent

The third recommendation, geared to federal, state and local governments, schools, industry and economic and workforce developers, is to conduct outreach to attract and retain skilled workers, which consists of a number of related dimensions. First, stakeholders should focus on raising the profile of manufacturing careers through education awareness campaigns at two scales. First, a national campaign should promote awareness of the importance of manufacturing to MI's economy (such as in the style of the Pure Michigan campaign), including extensive social media outreach designed to motivate students, attract job seekers from abroad, and retain skilled talent.

Second, and in conjunction with national outreach efforts, local awareness campaigns should be rolled out to focus on attracting area youth to enroll in local college programs and / or work in local industries. This could consist of a variety of different activities such as media campaigns invoking the personal stories of local entrepreneurs, public tours of local manufacturing plants (geared towards not only students but also their parents and guidance counselors), job shadowing opportunities to get young students into the workplace and on the factory floor, and summer camps for young children such as JAMA's "*Machining U*" and "*I Can Make It*!", which have already been discussed. These camps succeed not only in raising STEM literacy among young students, but also in providing an exposure to the types of manufacturing work that children can potentially pursue. Another successful outreach program is MMCC's *Plasti-Van*, a traveling scientific education program that offers secondary and high school students a hands-on lab experience investigating the technology, chemistry and processing of plastic in the local plastics manufacturing sector.

Moreover, outreach, at both the national and local levels, should focus on educating the public about the actual state of U.S. manufacturing today, and the abundance of rewarding, well-paid, stable opportunities in local industries. This public awareness should promote an understanding of the nature of production work, which has changed significantly from an earlier era. Whereas historically, the industry was reliant on distinct occupational skill sets and repetitive tasks (i.e. electricians, mechanical technicians, engineers), today it requires a far more complex blending of different types of skills. As well, increases in automation and the rapid enhancement of computer aided technology means that much of U.S. production offers high tech, fast paced work in a dynamic, rapidly evolving and stimulating environment.

> *"It starts with teaching the young people and their parents about the jobs that are available in manufacturing, especially in the plastics industry, to taking them on plant tours, to getting their career advisors out of the high schools into the plants, so they understand."* Interviewee, Mid-MI Community College

Finally, when devising outreach campaigns, it is imperative to address the unique needs of low income and disadvantaged students who may suffer from the pervasive impacts of generational poverty and, consequently, lack a basic preparedness to succeed academically. Given the socio-economic characteristics of some of the communities it serves, MMCC has led the way in its efforts to assist low income, disadvantaged and potential first-generation college students. Through funding from the U.S. Department of Education's Talent Search Program (ETS), the college provides an array of programs and services to over 500 area youth from participating schools from grades 6 all the way through to 12. ETS is aimed at both broadening student experience through exposure to cultural diversity, as well as providing a myriad of mentoring and advising services to students and their parents throughout the duration of their high school studies. The goal is to provide the support and mentoring needed to assist these students to continue education past high school and enroll in post-secondary education programs. With an 85% success rate in its first year, Talent Search is a key component of MMCC's efforts to help

local students reach their academic potential, enhance retention rates for college programs, and, in the long run, minimize labor shortages in local industries.

Adopt a 'High Road' Manufacturing Strategy

The final recommendation suggests that manufacturing firms adopt a 'high road' strategy. In other words, a high wage, high skill, high job security strategy in which workers are recognized as a company's greatest knowledge asset, rather than dispensable in the wake of an economic downturn. To achieve a high road strategy, producer firms must make ongoing training investments in their workers in order to adapt to the incredibly fast pace of technological change. As well, managers should adopt practices aimed at encouraging worker engagement, advancement and loyalty. This includes not only monetary incentives like competitive salaries and benefits, but also practices that promote the sharing of knowledge and the ongoing participation of skilled workers in product and process innovation on the shop floor.

> *"The companies that have done well have a very strong culture of training their own, so they utilize their own existing workforce as mentors to train the youth. And that's really helped them to be successful and to retain those young workers."* Interviewee, Michigan Manufacturers Association

Research from the preliminary study of machinery manufacturers in Michigan shows that these globally competitive firms are getting it right - and here is the reason why (Figures 9 and 10). For one, workers in the surveyed firms have a very high level of formal education, with an average of 35% of the workforce holding technical diplomas, and nearly half (48%) with university degrees. On top of that, shop floor employees receive an additional 233 hours of training on average each year, which is a considerably large training investment. While on the job training (OJT) was the most common method employed, a surprising finding was that all firms send their shop floor workers offsite to train in addition to OJT, which is presumably a far more costly method.

Figure 9: Characteristics of surveyed firms (n=3)

firm size (number of employees) (range)	137 (10-250)
firm age	49
location	Beaverton; Grand Rapids
% with vocational education / technical certificate	35%
% with college / associate's degree	48%
profile of workforce background	people with experience in the following industries: defense, auto, steel cutting and other CNC related industries; local farm workers
do you have an HR department?	67% YES; 33% NO
training hours per year	233
percentage workforce lost to other firms 2009-2012	6%

Figure 10: Are the following practices aimed at promoting company loyalty highly important to firm success?

	competitive salary / wages	benefits	investments in training	opportunities for career advancement and growth in company (i.e. via job rotation)	participation in innovation and strategic decision-making	cooperative management-labor relations	strong corporate brand	positive public image
1	x	x	x	x			x	x
2	x	x	x		x	x		
3	x	x	x	x	x	x		

Companies also reported a remarkably low turnover rate, with a mere 2% of their workers on average lost to other firms each year. In terms of human resources practices aimed at encouraging this high degree of worker loyalty, the most important factors cited were: competitive salaries and wages; benefits; and investments in training, with all firms reporting these as highly important to firm success. In a related vein: opportunities for advancement and growth in company; participation in strategic decision making and innovation; and cooperative management-labor relations were highly important to two-thirds of surveyed firms (Figure 11). These findings point to the importance of loyalty measures aimed at promoting worker engagement and stability to create the optimal long-term conditions necessary for training investments. As one senior manager puts it, "It's no secret that one of the retention tools, of course, is continuing education."

"If you want a good workforce, you have to pay for it." CEO, MI machinery manufacturer

Findings from this preliminary study of manufacturing companies in this niche machinery sector in Michigan indicate that successful firms adopt forms of economic organization that depart from the logic of the U.S. national regulatory framework in order to achieve a high skill, high road manufacturing strategy. This production model has been vital to the ability of these companies to compete in global markets.

The author's previous research on the high-end corporate furniture sector in Canada (Hatch, 2013b) is complementary to the above findings on the industrial practices of thermoforming and CNC machinery producers in Michigan. Research shows that lead furniture companies also adopt human resources practices that promote worker loyalty, engagement and long-termism in the workplace. Similarly, these incentives are both monetary and nonmonetary in nature, and include such things as competitive salaries and wages, benefits (i.e. paid leave, pension etc.), performance-based pay (i.e. bonuses, profit-sharing, stock options / ownership etc.), opportunities for career advancement and growth in the company, strong corporate brand, positive public image, positive working conditions, cooperative management / labor relations, investments in skills and training, and investments in a culture of motivation (i.e. programs to recognize employees). Furniture companies that have adopted practices aimed at encouraging loyalty place a higher emphasis on the development of a highly- and multi-skilled workforce (in spite of the institutional constraints that might counter such goals). Research shows that they have also produced a production regime that is more design-intensive, high quality, flexible and customized than their competitors. In addition, these high road firms have a commensurately higher sales performance and productivity than their low road counterparts. This research therefore attests to the role of corporate strategy in overcoming certain aspects of the institutional environment in which Canadian firms operate. It also points to the potential of firm practice to shape the skills, training and tenure dimensions of the Canadian industrial workplace, which is similar to that of the U.S.

Summary of Key Recommendations

Federal, state and local governments along with secondary / high schools, universities, community colleges and industry	**FORM ALLIANCES BETWEEN BUSINESS AND EDUCATION**
	Build effective public private partnerships, in which community colleges collaborate with local industry to create programs essential to support economic development efforts
	Educators at the K-12 and community college / post-secondary level need to be willing to engage with manufacturers and invite them to consult on the curriculum development process
	Industry and labor leaders should develop state-of-the-art training programs that integrate individuals into the workplace and give both teachers and students hands-on experience in the lab, the factory floor and in the field
	Integrate academic and technical education programs across universities and community colleges and ensure that students are taught to a rigorous standard aligned with technical and industry requirements
	Prioritize Career and Technical Education (CTE) programs and push for greater integration of community colleges in the innovation pipeline
	Community college programs and course offerings designed to upgrade the skills of area manufacturer employees should be flexible and where

	possible be offered via the Internet in order to align to the demands of business
	In order to collaborate and communicate with industry, educators should create a flexible, open forum format. To this end, the Internet, social media and virtual forms of communication such as 24/7 email listservs should be used instead of face-to-face meetings. With this approach, schools can effectively seek consultation from industry for purposes of course development; inform industry of the profiles of graduating students who may fill specific occupational needs; and work collaboratively fill talent pipeline needs
Congress, states, academia and industry	**EXPAND STEM EDUCATION**
	Initiate K12 pilots and programs that emphasize team-based, experimental and interdisciplinary learning geared toward problem solving
	Support programs that integrate arts education into traditional STEM instruction, sometimes known as STEAM. Studies suggest that exposure to the arts is linked to higher student performance in traditional STEM disciplines
	Use creative approaches to develop programs geared to young children in order to expose children to STEM principles and shape career trajectories at a young age (4th-6th grades) i.e. summer camps
	Encourage and support high school students' exposure and participation in engineering and manufacturing projects oriented towards work in production-related fields
Congress, states and local government, education institutions,	**CONDUCT OUTREACH TO ATTRACT AND RETAIN WORKERS**

economic and workforce developers, industry	Raise the profile of STEM and manufacturing careers with a national awareness campaign including extensive social media outreach designed to motivate students, attract job seekers and retain talent
	National campaign should be rolled out in conjunction with localized advertising and outreach efforts to compel local area residents to embark on careers in manufacturing in local industries
	Local outreach and awareness activities targeting not only students but their parents and school guidance counselors can include such things as tours of local manufacturing plants, fieldtrips, overnight camps and other immersion activities and job shadowing
	Address the unique needs of rural students, many of whom may suffer the impact of poverty and lack basic academic preparedness essential for college entrance and completion. Colleges can provide low income students with the mentoring and services they need to be successful through funding from the Educational Talent Search Program, U.S. Department of Education. This program provides annual funding for a period between grades 6 and 12 to assist area youth to continue their education past high school and enroll in post-secondary institutions
Manufacturing firms	**ADOPT A HIGH ROAD STRATEGY**
	This means adopting a high job security, high wage, high skill, high productivity strategy as an investment in innovation
	Recognize that the competitive success of your company is dependent on the quality and supply of skilled labor to your firm, as well as the way in which workers are organized to ensure their involvement in innovation

	Avoid short-term cost cutting (i.e. laying off skilled workers during a downturn)
	Devote significant funding to in-house (and offsite) training programs
	Adopt strategies to promote worker loyalty, engagement and long-termism in the workplace. These incentives are both monetary and nonmonetary in nature, and include such things as competitive salaries and wages, benefits (i.e. paid leave, pension etc.), performance-based pay (i.e. bonuses, profit-sharing, stock options / ownership etc.), opportunities for career advancement and growth in the company, strong corporate brand, positive public image, positive working conditions, cooperative management / labor relations, investments in skills and training, and investments in a culture of motivation (i.e. programs to recognize employees).
	Given the increased complexity of the product development process, it is advised that companies do not outsource the recruiting and HR functions to external staffing agencies. Due to the increased skill- and knowledge-intensity of products and production processes, these functions should be considered core competencies of firms, and therefore kept in-house. Outsourcing the HR function creates a temporary mindset in the workforce, encourages turnover, and negatively impacts the relationship between labor and management.

CONCLUSION: Summary of Key Findings

This co-learning plan began by highlighting debates concerning the presence of a so-called skills gap in the Michigan manufacturing sector, with some arguing that it is a microcosm of a pervasive U.S. workforce development problem, yet others suggesting that the issue is not nationwide, but highly localized. It then provided much needed context by discussing why skills have become so important to competitiveness in the contemporary economy, and why it is critical that stakeholders address the issue in the short-term, given the importance of manufacturing to MI's economy and the potential for long-term growth stemming from a U.S. manufacturing resurgence. It also provided a framework for understanding some of the key causal factors, including ongoing economic decline in the manufacturing industry, a pervasive stigma about manufacturing careers, a loss of talent pipeline, an aging workforce, and a lack of training investments by producer firms. Finally, this co-learning plan provided a set of best practice recommendations targeted to specific stakeholder groups to address skills shortages in their communities.

In summary, this co-learning plan shows that the most successful producer firms in dealing with the skills issue are those that not only collaborate with institutions and actors in their local supply chains and industrial clusters to create industry-driven curricula, but also minimize their labor force turnover through heavy investments in the training and long term development of their workers. Moreover, when considering the development of collaborative alliances between industry and academia, this report also shows that there is not a *one-size-fits-all* solution; rather, policy makers need to be sensitive to geographical and industrial specificity in their communities. And finally, there a need for more research in order to understand best manufacturing training practices in an era of intensified technological- and skill-intensity on the shop floor.

APPENDICES

Appendix I: List of Interview Participants

	Interviewee	Location
1	CNC machine distributor	Grand Rapids, MI
2	CNC machine maker and distributor	Grand Rapids, MI
3	Economic Developer	Gladwin County, MI
4	Economic Developer	Gladwin County, MI
5	Independent Workforce Public Policy Consultant	Lansing, MI
6	Jackson Area Manufacturers Association	Jackson, MI
7	Manufacturing Institute	Washington DC
8	Michigan Economic Development Corporation	Lansing, MI
9	Michigan Manufacturers Association	Lansing, MI
10	Michigan Manufacturers Association	Lansing, MI
11	Michigan Manufacturers Association	Lansing, MI
12	Michigan Manufacturing Technology Center	Grand Rapids, MI
13	Michigan Workforce Development Agency	Lansing, MI
14	Michigan Workforce Development Agency	Lansing, MI
15	Michigan Workforce Development Agency	Lansing, MI
16	Michigan Works!	Gladwin County, MI
17	Mid-Michigan Community College	Harrison, MI
18	Mid-Michigan Community College	Harrison, MI
19	Thermo-former machine builder	Beaverton, MI

Appendix II: Industry Association Interview Guide

Personal background / career history

- What is your educational / career background?
- What is your position / portfolio at ---?

Background / mandate

- Please describe for us the mandate or mission of the ---.
- When was it founded and when was this office established?
- What special expertise policies or programs does --- have to offer with respect to the support and development of U.S. manufacturing industries? [Prompt: annual budget and size of staff dedicated to this sector?]

Repatriation

- To what extent has the nature of manufacturing work in the U.S. changed during the last / next 5 years?
- To what extent do you see a repatriation of manufacturing activity back to the U.S.? How will this shape the demand for skilled, qualified workers going forward?

HR function

- To what degree, in your opinion, have companies in the U.S. outsourced the recruitment and HR function to temporary and other types of employment agencies? If there is such a trend, how has it impacted both firms and workers (in terms of engendering a temporary mentality etc.)

Training and skills

- Compared to other high-wage manufacturing powerhouses like Germany and Japan, do U.S. firms invest adequately in the training, retention and long-term development of their workers?
- In terms of training provision, what is the role of educational institutions (elementary, secondary and postsecondary) versus private sector firms?
- How has / how will the increased technological intensity and changing nature of manufacturing work influence training provision in the next 5 years?
- Is there a skills gap in the industry? If so, how would you define it?
- If companies increased wages and benefits and demonstrated loyalty, do you think they would improve the quality and supply of local applicants?
- What are some of the causal factors of the skills problem?
- How will this problem change in the next 5-10 years?
- How has the skills gap adversely affected the performance of U.S. companies? Examples?
- What are some solutions to the skills problem?

Factors of competitiveness

- What are the key trends (challenges or opportunities) that will most influence the growth of the industry in the next five years (as we enter a new phase of intensified globalization)?

- What are the most important challenges or obstacles facing the industry?

Appendix III: Vocational Education Interview Guide

Background

- What events stimulated the founding of this college and its manufacturing programs? Who were the individuals and/or organizations who played a key role in its development?
- Are there any specific companies in this region and/or province that your college is associated with?
- What are the current advantages of this particular location?

Research Strategy and Innovation

- What special expertise or experience does your college have to offer with respect to the support and development of key local industries?
- What are your main sources of new students?

Other Firms	(local/nonlocal)
Postsecondary Institutions	(local/nonlocal)
Specialized Training Institutions	(local/nonlocal)
Other Institutions/Programs	(local/nonlocal)

- Which programs are most / least successful and why?
- Does the labor force in your locality or region possess any distinctive or unique sets of skills, knowledge or capabilities that are an asset to the companies associated with your college/organization? What role does your college play in creating this unique knowledge base or set of skills?
- Tell us about employees who have left your college within the last three years; how many have been employed by firms within your region/locality?

Cluster dynamics

- How frequently do you or others in your college interact with companies (local or non/local), to develop educational programs? What kind of interaction?
    - " development of specialized training program for companies
    - " company personnel working with your research college/organization
- Tell us more about how these relationships developed or evolved.
- What primary benefits do the companies involved derive from these relationships?
- How many of these relationships are locally based and what additional benefits do the companies involved derive from close proximity to your college?
- Do you consider your college to be part of a network of related firms in your region/locality, i.e. a cluster? What evidence is there of this?
- Are there any specific events that played an important role in the development of this local industry or cluster? If yes, explain. What role did your college play in these events?
- Are there any unique local assets or capabilities that have contributed significantly to the development of this local industry or cluster? If yes, explain.

Future

- What are the key trends (challenges or opportunities) that will most influence the development of your manufacturing curriculum in the next five years?

Skills Gap

- Is there a skills problem in the economy, and more specifically, in manufacturing?
- If so, what is it attributed to?
- What occupational areas are affected the most, and why?
- What is the role of your college in trying to mitigate this problem?
- What are some of the challenges you're having?
- How will this problem change in the next 5-10 years?
- What are some solutions to this problem?
- Is there anything that I've missed?

Appendix IV: Firm Interview Guide

Background

- What's your background?
- Why are you located there? What are the advantages/disadvantages?
- Please estimate (as best you can) the total number of employees in your firm: _____
- Please estimate (as best you can) the percentage of your full-time employees in your plant in 2012 who had:
- A university degree _____%
- A college/technical institute diploma _____%
- What percentage of your workforce, if any, is unionized?
- _____ %
- Public / private?

Performance and innovation

- A PRODUCT INNOVATION is the market introduction of a new good or a significantly improved good. The innovation (new or improved) must be new to your plant.

During the last three years, did your plant introduce:

New or significantly improved goods Yes No

If yes, during the last three years (2010-2012), how many new or significantly improved PRODUCTS did your plant introduce onto the market?

Number of new goods: _____.

During the three years, 2007 to 2009, were ANY of your new or significantly improved PRODUCTS introduced by your plant:

	Yes	No	Do not know
a. A first in your province/territory?			
b. A first in the U.S.?			
c. A first in North America?			
d. A world first?			

- A PROCESS INNOVATION is the implementation of a new or significantly improved production process, distribution method, or support activity for your goods or services. The innovation (new or improved) must be new to your plant.

During the last three years (2010-2012), did your plant introduce:

New or significantly improved methods of manufacturing or producing goods or services

Yes No

New or significantly improved logistics, delivery or distribution methods for your inputs, goods or services

Yes No

New or significantly improved supporting activities for your processes, such as maintenance systems or operations for purchasing, accounting, or computing

Yes No

During the three years, 2007 to 2009, were ANY of your new or significantly improved PROCESSES introduced by your plant:

	Yes	No	Do not know
a. A first in your province/territory?			
b. A first in the U.S.?			
c. A first in North America?			
d. A world first?			

Recruitment and training

- Where do you recruit your manufacturing labor force from? Why? More specifically:
- Please rate the importance of the following sources for employees for each production occupational category.

	Degree of importance			
	Low	Medium	High	Not relevant
Supervisory and skilled production workers				
Internally (promotion)				
Secondary education (high school)				
College/university				
Specialized vocational training institutions				
Trades and apprenticeship system				
Other firms in the sector or industry				
Other firms outside the sector or industry				
Immigration				
Other (specify)				
Semi- and un-skilled production workers				
Secondary education (high school)				
College/university				
Other firms in the sector or industry				
Other firms outside the sector or industry				
Immigration				
Other (specify)				

- Do you have an HR Department?
- Do you use temporary employment agencies? If so, what are the advantages / disadvantages?
- Where does the training provision for your manufacturing workers happen?
    - For incumbents from recognized vocational programs, as well as other workers, do you provide training or financial support for their training and development following recruitment?
    - Yes No

- If No, why not? Please check all that apply:

  ___ Too costly

  ___ Investment in labor force training not deemed important for competitive strategy

  ___ Fear that skilled workers will be poached/raided by competitive firms

  ___ Other (Specify) _____

If Yes, which of the following does your firm use? Please check all that apply.

	on-the-job training, in-house	classroom education in-house	online training	education/training off-site
Supervisory and skilled production workers				
Semi- and un-skilled production workers				
Other (Please specify)				

- What is the average total number of training hours per year per employee for each of the following job categories?

	Average number of annual training hours per year per employee
Skilled production workers	
Semi- and un-skilled production workers	

- Are there opportunities for advancement for your production workers?
- To what degree do in-house training and job rotation schemes promote continuous skills formation and systematic career progression for your shop floor workforce?
- To what extent are workers encouraged to (or have the opportunity to) share their knowledge of improvements in product and process? What are some examples that you can think of?
- What is the role of education and training institutions? Which ones?
  How does college training provision differ from what you offer in-house? Do you collaborate with local colleges and schools to develop programs that train workers that meet your needs? Are these collaborations successful? What are some of the challenges and gaps?

Tenure / retention

- How difficult is it to ATTRACT and RETAIN semi-skilled and skilled production workers?
    - What challenges, if any, do you currently face with respect to the attraction and retention of your shop floor workers, (supervisory, skilled, semi-skilled)?
    - What are some of the practices you have developed aimed at attracting and retaining skilled manufacturing workers to your company? What are the most successful ones, and why? More specifically:
    - Please rate the importance of the following factors and incentives for attracting and retaining workers to your firm.

	Degree of importance			
	Low	**Medium**	**High**	**Not relevant**
Competitive salaries/wages				
Benefits (i.e. paid leave, pension etc.)				
Performance-based pay (i.e. bonuses, profit-sharing, stock options/ownership)				
Strong corporate brand				
Positive public image				
Opportunities for career advancement and growth in company				
Investment in skills and training				
Investment in culture of motivation (i.e. programs to recognize employees etc.)				
Positive working conditions				
Cooperative management-labour relations				

- During the last 3 years (2010-2012), how would you describe the rate of turnover in your workforce relative to (a) – other firms in the same industry in the U.S. and (b) employers in other manufacturing sectors?

	Other firms in the same industry in the U.S.				Employers in other manufacturing sectors			
	lower	equal to	higher	don't know	lower	equal to	higher	don't know
Skilled production workers								
Semi- and un-skilled production workers								

- If your rate of workforce turnover was above-average for your industry during the last 3 years (2010-2012), what were the most important reasons for this? Please check all that apply:
  ___ Lower wage rates relative to other employers
  ___ Benefits
  ___ Working conditions
  ___ Other (Specify) _____
  ___ Not relevant

- Have you lost any of your workforce to other firms during the last 3 years (2010-2012)? Yes No
- If yes, how many? _____

Downturns

- When your firm encounters downturns in business, how does it manage its labor force: Please check all that apply.
  ___ Cut overtime
  ___ Encourage voluntary leave
  ___ Lay-off workers
  ___ Cut wage rates
  ___ Increase worker productivity
  ___ Short work week/shorter shifts
  ___ Share core workers/collaborate with other firms
  ___ Long-term reallocation of core skilled workers (i.e. craftsmen) to new tasks
  ___ Government work share programs
  ___ Other (Please specify:_____)

Skills gap

- To what extent has the nature of manufacturing work in your industry changed during the last 5 years? What are some of the changes you foresee in the next 5 years?
- Is there a skills problem in this industry?
- If so, what's causing it? What occupational areas are affected the most?
- How are you attempting to deal with the problem? Do you think if you increased wages, benefits and employee loyalty that you would improve the quality of applicants seeking work in your sector?
- What are some solutions to the skills problem?

Factors of competitiveness

- What are the most important factors that have promoted the growth and innovativeness of ----?
- What are the most important factors, locally and non-locally, that inhibit the growth and innovativeness of ----?

Future

- What are the key trends (challenges or opportunities) that will most influence the growth of ---- in the next five years (as we enter a new phase of intensified globalization)?
- What are the most important challenges or obstacles facing the company?

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[i] According to the Michigan Manufacturing Association, MI is second in R&D spending, behind California, and first in industrial R&D intensity in the country, with more than 85 percent of the North American automotive R&D occurring in this state.

[ii] For instance, between 2003 and 2007, MI's advanced manufacturing industry experienced a decline in employment (negative 10.5%) yet an increase in payroll (positive 0.7%), suggesting that MI's average wage in the advanced manufacturing industry grew by 12.6% during this period (and 1% higher than inflation) (Anderson Economic Group 2010).

[iii] (Economist 2005 http://www.economist.com/node/4462685).

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The MSU EDA University Center for Regional Economic Innovation (REI) seeks to identify and develop new economic development tools, models, policies and practices to support innovative economic development high-growth enterprises and job creation in distressed regions across the state. REI has established a new economic development ecosystem to cope with the ever-changing global and regional dynamic. Through this ecosystem, we engage innovative and creative minds which result in new economic development practices.

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