NATIONAL OCCUPATIONAL RESEARCH AGENDA (NORA)

National Occupational Research Agenda for Manufacturing

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Developed by the NORA Manufacturing Sector Council

INTRODUCTION

What is the National Occupational Research Agenda?

The National Occupational Research Agenda (NORA) is a partnership program to stimulate innovative research and workplace interventions. In combination with other initiatives, the products of this program are expected to reduce the occurrence of injuries and illnesses at work. Unveiled in 1996, NORA has become a research framework for the Nation and the National Institute for Occupational Safety and Health (NIOSH). Diverse parties collaborate to identify the most critical issues in workplace safety and health and develop research objectives for addressing those needs.

NORA enters its third decade in 2016 with an enhanced structure. The ten sectors formed for the second decade continue to prioritize occupational safety and health research by major areas of the U.S. economy. In addition, there are seven cross-sectors organized according the major health and safety issues affecting the U.S. working population. While NIOSH is serving as the steward to move this effort forward, it is truly a national effort. NORA is carried out through multi-stakeholder councils, which are developing and implementing research agendas for the occupational safety and health community over the decade (2016-2026). Councils address objectives through information exchange, partnership building, and enhanced dissemination and implementation of evidenced-based solutions.

NORA groups industries into ten sectors using North American Industry Classification System (NAICS) codes. The Manufacturing sector encompasses NAICS code groupings 31 to 33. The Manufacturing sector includes establishments engaged in the mechanical, physical, or chemical transformation of materials, substances, or components into new products. The assembling of component parts of manufactured products is considered manufacturing, except in cases where the activity is appropriately classified in Sector 23, Construction. Establishments in the Manufacturing sector are often described as plants, factories, or mills and characteristically use power-driven machines and materials-handling equipment. In 2015, over 15 million U.S. workers were employed in 21 manufacturing sub-sectors, including Food, Beverages, Tobacco, Textiles, Petroleum, Chemicals, Metals, Machinery, Computers, Transportation Equipment, and Furniture Manufacturing. The largest sub-sectors were Transportation Equipment Manufacturing, Fabricated Metal Products Manufacturing, and Food Manufacturing (2015 Current Population Survey, http://www.bls.gov/cps/cpsaat18.pdf , accessed February 20 16, 2017).

What are NORA Councils?

NORA councils consists of a broad group of participants, including stakeholders from universities, large and small businesses, professional societies, government agencies, and worker organizations. Councils are co-chaired by a NIOSH senior leader and a senior-level external partner.

Statement of Purpose

NORA councils are a national venue for individuals and organizations with common interests in occupational safety and health topics to come together. Councils are starting the third decade by identifying broad occupational safety and health research objectives for the Nation. These research objectives will build from advances in knowledge in the last decade, address emerging issues, and be based on council member and public input. Councils will spend the remainder of the decade working together to address the agenda through information exchange, collaboration, and enhanced dissemination and implementation of solutions that work.

Although NIOSH is the steward of NORA, it is just one of many partners that make NORA possible. Councils are not an opportunity to give consensus advice to NIOSH, but instead a way to maximize resources towards improved occupational safety and health nationwide. Councils are platforms that help build close partnerships among members and broader collaborations between councils and other organizations. The resulting

information sharing and leveraging efforts promote widespread adoption of improved workplace practices based on research results.

Councils are diverse and dynamic, and are open to anyone with an interest in occupational safety and health. Members benefit by hearing about cutting-edge research findings, learning about evidence-based ways to improve safety and health efforts in their organization, and forming new partnerships. In turn, members share their knowledge and experiences with others and reciprocate partnerships.

Manufacturing Council

The NORA Manufacturing Sector Council was created in 2006 at the start of the second decade of NORA to promote dialogue and facilitate the development of partnerships to improve occupational safety and health for manufacturing industries. Manufacturing Council members include stakeholder partners from academia, trade/professional organizations, industry, insurers, unions, and government agencies. Drawing on their collective experience and knowledge, the Council assesses the needs of the Manufacturing industry sector; encourages new research; and promotes the adoption of effective, evidence-based workplace interventions. Input from external partners is critical to assessing the state of the field, for conducting new research, and for communicating findings to make positive changes in the workplace. Comments on sector goals and the direction of research and prevention activities are always encouraged.

What does the National Occupational Research Agenda for Manufacturing represent?

The National Occupational Research Agenda for Manufacturing is intended to identify the research, information, and actions most urgently needed to prevent occupational injuries, illnesses and fatalities in the Manufacturing Sector. This National Occupational Research Agenda for Manufacturing provides a vehicle for manufacturing industry stakeholders to describe the most relevant issues, gaps, and safety and health needs for the sector. Each NORA research agenda is meant to guide or promote high priority research efforts on a national level, conducted by various entities, including: government, higher education, and the private sector.

The Agenda is intended to guide national occupational safety and health efforts for the Manufacturing Sector, and is not an *inventory* of all issues worthy of attention. The omission of a topic does not mean that topic was viewed as unimportant. Those who developed this Agenda believed that the number of topics should be small enough so that resources could be focused on a manageable set of objectives, thereby increasing the likelihood of real impact in the workplace. The agenda identifies the potential synergies to be developed during the decade.

NIOSH will use the Agendas created by the sector and cross-sector NORA councils to develop a NIOSH Strategic Plan. Programs will use concepts of burden, need, and impact criteria to write research goals that articulate and operationalize the components of the NORA Sector and Cross-Sector Agendas that NIOSH will take up. NORA Agendas and the NIOSH Strategic Plan are to be separate but linked.

Who are the target audiences?

The National Occupational Research Agenda for Manufacturing provides guidance on significant safety and health issues to industry, labor, federal, state, and local governments, as well as to experts in professional associations, academia, and public interest/advocacy groups. It can be used to improve the health and safety of manufacturing workers by providing areas of focus for partnering efforts. The Agenda will provide guidance to investigators concerning where information is lacking and what gaps need to be addressed in future research and other actions. With the goal of establishing and maintaining a national agenda while fostering partnerships to improve the practice of occupational safety and health, we continuously engage diverse stakeholders, disciplines, interests and perspectives.

How was the research agenda developed?

The National Occupational Research Agenda (NORA) Manufacturing Sector Council was given the dual role of establishing and maintaining a national agenda while fostering partnerships to improve the practice of occupational safety and health. The Council convened for a day-and-a-half meeting in February, 2017 to exchange information on research needs and how to better move research to practice within workplaces. Seventeen external participants and twelve NIOSH researchers discussed available and needed surveillance data, and provided expert input on the state of the field and the industry. Minutes were taken to record key themes (not verbatim comments). Breakout groups engaged in in-depth discussions on the needs for occupational safety and health research particular to the manufacturing industry, and for its dissemination, and directions for strategic planning. Following the meeting, the Council leadership analyzed the input received by identifying themes that emerged in the discussions, the level of agreement on each theme, the frequency in which they were mentioned, and intersections between them. Using this analysis, the Agenda was drafted and circulated to the Council for review. Their comments were then addressed in the current version of the Agenda. The goals are not presented in any particular or prioritized order. The numbering conventions are used only to facilitate the tracking of comments and implementation efforts.

Much of the discussions during the February 2017 Council meeting focused on the profound changes that are reshaping the manufacturing sector in the United States, including the technological surge in advanced manufacturing. Advanced manufacturing, which combines new information technology capabilities with advanced machinery techniques, is a trend resulting from manufacturing investments in new technologies from companies that were founded within the last 15 years [Reynolds et al. 2015].

THE OBJECTIVES

Objective 1: Reduce the burden of acute and chronic occupational illnesses, injuries and fatalities in manufacturing by a) enhancing knowledge of occupational safety and health hazards and their effects, and b) developing effective interventions to reduce exposure to known occupational safety and health hazards.

Despite advances in our knowledge of the relationships between work and illness, injuries and fatalities, research is needed to identify, investigate, and track agents, processes, and new technologies that are associated with health and safety risks, potential hazards, and new diseases in the manufacturing sector.

In the U.S. and worldwide the risk to life and health stemming from occupational safety and health issues remains significant [Concha-Barrientos et al. 2005; Hämäläinen et al. 2009]. For example, dust-related lung diseases and injuries such as falls from heights continue to cause fatalities every year. Exposure to hazards associated with repetitive hand-intensive work, manual material assembling and handling, nanomaterials, excessive noise, and chemicals contribute greatly to debilitating acute and chronic conditions in the manufacturing industry. Given the changes in the manufacturing sector around new technologies and employment arrangements, new knowledge is needed to prevent illnesses, injuries, and fatalities in manufacturing and control exposures and hazards, particularly in small businesses. Evidence is also needed regarding the effectiveness of interventions designed to reduce or prevent workplace illnesses, injuries and fatalities. While many workplaces comply with legal or obligatory requirements and implement recommended interventions, few publications exist documenting the long-term effectiveness of these actions. Peer-reviewed information on the effectiveness of the many strategies and approaches currently in use could help correct weaknesses, or further encourage their adoption and expansion.

The specific needs in terms of health and safety outcomes and exposures of concern are introduced in brief below. Additional discussion of the issues raised in sub-objectives 1.1 to 1.4 are provided in the NORA Agendas from the cross-sectors on Traumatic Injury Prevention; Cancer, Reproductive, Cardiovascular and Other Chronic Disease Prevention; Hearing Loss Prevention; Musculoskeletal Health; and Respiratory Health.

Objective 1. 1 Improve workplace safety to reduce traumatic injuries and fatalities in the manufacturing sector.

In the manufacturing industry, a common cause for injuries is associated with contact of workers with machinery and equipment. Data from the U.S. Department of Labor, Bureau of Labor Statistics (BLS) indicate that the highest number of injury cases involving days away from work from contact with machinery and equipment is from manufacturing [BLS 2016]. The 2017 Liberty Mutual Workplace Safety Index indicated that the direct cost of the combined workplace injuries due to being struck by/against or caught in/compressed by objects or equipment was estimated to be $8.32 billion in 2014 alone, which accounted for 14% of the total annual cost burden [Liberty-Mutual 2017]. Market data indicate that the use of new types of industrial machines will continue to grow rapidly. For instance, it is estimated that more than 1.4 million new industrial robots will be installed in factories worldwide between 2016 and 2019 [IFR 2016] and that there will likely be increased availability and sales of collaborative robots designed to work alongside and in cooperation with human workers. Increasing prevalence of traditional industrial robots in the workplace could contribute to more deaths and injuries of workers when existing control strategies are not used, while newer types of robots and robotics technology may introduce unforeseen hazards.

Objective 1. 2 Contribute to the reduction of chronic diseases such as respiratory diseases, occupational cancer, cardiovascular disease, neurologic diseases and adverse reproductive outcomes.

Serious chronic diseases such as respiratory diseases, occupational cancer, cardiovascular disease, neurologic diseases, and adverse reproductive outcomes have been associated with occupational exposures. Among respiratory diseases, the highest burden in manufacturing arises from chronic obstructive pulmonary disease, work-related asthma, and work-related interstitial lung diseases. Exposures of concern include beryllium, respirable silica and elongated mineral particles [Cullinan et al. 2017; Fishwick et al 2015]. Several potential exposures in the workplace are also associated with lung cancer, which is not the only type of cancer which can develop from workplace conditions. NIOSH surveillance data indicates that the following cancers are an important source of morbidity among workers in the manufacturing sector: Lung and Bronchus Cancer (Attributable fractions or AF = 8-11 %); Mesothelioma (AF = 1-19 %); Leukemia (AF = ~4%); Laryngeal Cancer (AF = 2-7 %); and Sinonasal and Nasopharynx Cancer (AF = 41-54%) [Groenewold et al. 2017]. Toxicants with known reproductive and developmental effects which are in regular commercial use in the manufacturing sector include heavy metals and organic solvents. Etiologic research is needed to evaluate agents which are suspected of producing reproductive or developmental toxicity but for which sufficient data are lacking. Finally, exposure to welding fumes is common in the manufacturing industry and a concern exists about potential neurological effects from that work task, specifically concerning exposure to manganese in welding fumes. While prolonged exposure to high manganese concentrations in air may lead to a Parkinsonian syndrome known as “manganism,” research is mixed concerning neurological and neurobehavioral deficits occurring when workers are exposed to low levels of manganese in welding fumes over time. Workers performing welding operations in these sectors may experience other exposures as well - such as to lead, iron, carbon monoxide, and heat stress – which can also contribute to neurological impairments.

Objective 1.3 Contribute to the reduction of occupational musculoskeletal disorders in manufacturing.

The structure of occupational tasks within the Manufacturing Sector is changing rapidly due to increased mechanization, and it is common for workers to perform their tasks side-by-side with robots. Manual material handling tasks, while not entirely eliminated, have also changed dramatically in the last 25 years. According to the Bureau of Labor Statistics, for the year 2015 the injury incidence rate for the more severe days-away-from-work injuries is 99 per 10,000 equivalent full-time workers, slightly higher than the rate for all privately owned establishments at 93.9 [BLS 2017]. The incidence rate for musculoskeletal injuries resulting in days-away-from-work for Manufacturing is 33.4 per 10,000 equivalent full-time workers compared to an incidence rate of 29.8 for all private establishments. This translates to approximately 41,000 severe MSD injuries in Manufacturing for that year. Research is needed: 1) to quantify the effects of the mechanization of the work environment on risk exposure and on the development of work-related MSDs; 2) to revise, refine and validate existing risk assessment tools to account for increased task variability across the work shift; and 3) to develop ergonomic interventions which take into account the changing workloads and risk exposures whether from administrative changes, such as job enlargement, or from processes changes.

Objective 1.4. Contribute to the reduction of occupational hearing loss in manufacturing.

Since 2004, the Department of Labor has collected data on the OSHA Form 300 Log for cases of work-related hearing loss and the Bureau of Labor Statistics annually reports these data. The incidence for hearing loss in manufacturing was slightly less than 20,000 workers in 2015 [BLS 2016]. The BLS data are a partial sample and do not yield representative data. To further demonstrate the burden of hearing loss, NIOSH has partnered with hearing conservation providers to collect audiometric data from a broad spectrum of sectors. These data have been analyzed to provide estimates of prevalence and describe trends for hearing loss by sector [Masterson et al. 2015]. The burden for noise-exposed workers in the Manufacturing sector was about 20%. While the general trend in the past two decades has been one of decline in prevalence in hearing loss, additional research and dissemination efforts are needed. These include better understanding of risk factors (impulse noise, aging, and other agents), new hearing protection technologies, and intervention effectiveness of prevention efforts. Updated recommendations towards these risk factors and the incorporation of new technologies (such as the integration of fit testing) within hearing conservation programs are needed.

Objective 2: Improve surveillance of work-related hazards, exposures and illnesses in the manufacturing industry

Improved surveillance is needed for a more accurate appraisal of the occupational safety and health needs within the manufacturing sector. While national estimates available from the BLS provide reasonable estimates for work-related fatalities and injuries, similar estimates for acute and chronic occupational illnesses are inadequate, as they are more difficult to estimate. Therefore, to prevent or reduce the burden of occupational illnesses, new technological approaches need to be developed to identify, measure and track illnesses for which workers in the manufacturing industry are most at risk. Such documentation could ideally be standardized over the entire nation and would provide sector- and industry-specific data. Examples include advancing the ability to include industry and occupation and other metrics of work in Electronic Health Records, a more robust capture of work (industry and occupation data) in public health surveys and systems, and in case reporting of infectious diseases throughout the country. Lastly, a standardized approach to estimating the risk of workplace hazards for manufacturing sector jobs is needed to allow for a prioritization of efforts.

Objective 3: Examine emerging risks from new technologies and explore ways in which new technologies can advance occupational safety and health in manufacturing.

New technologies that are reshaping the manufacturing industry include: data processing capabilities, connectivity of devices and services, advanced robotics, nanotechnologies, a world of wearable devices, the Internet of Things, artificial intelligence, and virtual/augmented reality, etc. [Brynjolfsson and McAfee 2012; McAfee and Brynjolfsson 2016; NAS 2017]. There is a clear opportunity to benefit from this technological surge, and from the proliferation of direct-reading sensors and interconnected smart devices. However, this opportunity is accompanied by occupational safety and health as well as ethical concerns about potential abuse of the embedded sensing and intelligence placed into every device. Moreover, among the manufacturing community, the lack of guidelines creates concerns for security, deployment, and sustainability for industry and the workforce. One of the issues with the increasing number of Internet of Things devices is the inherent complexity that is required to operate them safely and securely. This increased complexity creates new safety, security, privacy, and usability challenges much greater than the challenges one faces when operating and/or securing a single device [Reynolds et al. 2015; Fu et al. 2017; Morley et al. 2017]. In short, research and guidance are needed so that new technologies in the physical world act in ways that complement and respect human activities.

Objective 4: Improve occupational safety and health for workers in non-traditional employment arrangements

New employment arrangements add another layer of challenges for creating a safe and healthy work environment in manufacturing. Under many names – temporary workers, contingent workers, contract workers, long-term temps, workers in dual employer situations, or on-demand freelance – these workers are becoming more common, and research suggests that temporary workers have higher rates of workplace injury and illnesses [Fabiano et al. 2008; Smith et al. 2010; OSHA 2013]. A report from the American Staffing Association showed that the highest proportion of staffing agency employees were assigned to industrial occupations (37%), which includes manufacturing, compared to other occupations (American Staffing Association Staffing industry facts and data).

Research, guidelines and policies have not kept pace with the growth in the temporary workforce. Key needs for research and dissemination of recommended practices for non-traditional employment arrangements were examined in a 2015 meeting co-hosted by the National Occupational Research Agenda Manufacturing Sector Council and Services Sector Councils, reported at https://blogs.cdc.gov/niosh-science-blog/2015/06/16/temp-workers/. Research needs include surveillance efforts, intervention, and translation research to assist both host and client employers in creating a safe and healthy workplace. Models on the determinants and effects of work arrangements, and efforts to improve the taxonomy of work arrangements and their characteristics are particularly needed. Additionally, the development of contract models and training platforms to provide workplace safety and health training to workers placed in host companies could improve safety and health, the management of temporary and contractor working arrangements and overall worker well-being.

Objective 5: Advance capacity-building and educational efforts in manufacturing.

Data from the Department of Labor indicate that the number of unfilled manufacturing jobs has been rising since 2009, and in January 2017 it reached the highest level of 364,000 in 15 years [BLS 2017]. As the manufacturing community seeks mechanisms to address the shortage of skilled labor and the need for continuous learning, an opportunity exists to contribute occupational safety and health content to new educational and training initiatives directed to manufacturing. For example, through its Safe • Skilled • Ready Workforce Program NIOSH developed Youth@Work: Talking Safety, a foundational curriculum for occupational safety and health designed for middle

and high school students. It could benefit the young people who will become the next generation of manufacturing workers. Other occupational safety and health tools and resources could be developed or adapted to blend occupational safety and health content with technical training. This approach would promote a safe and productive manufacturing workforce.

Objective 6: Develop mechanisms for effective translation of research into practice in the manufacturing sector.

The translation and transfer of research findings, technologies, and information into effective strategies and practices is challenging, but necessary to reduce and eliminate occupational injuries, illness, and fatalities. In recent years a proliferation of advertised solutions and products directed at the occupational safety and health community has taken place. In general these are not centralized, many are for the purpose of marketing and commercial interest, come in a variety of formats and vary widely in quality. While the term "best practice" has become commonplace, for practices to be accepted as best, they must truly be supported by evidence of effectiveness. That requires a stronger quality and quantity of evidence than a single case study in a specific environment with a specific group of affected workers. A coordinated communications effort among the various groups that work in this area could help highlight and promote existing programs and resources that are backed by quality research within the larger manufacturing community. The different stakeholders involved in NORA Councils have the knowledge, tools, access and opportunity, and are strategically positioned to improve the dissemination of existing solutions on work-related risks and prevention of illnesses and injuries. The Manufacturing Council aims to explore how to use the dissemination mechanisms available to Council members in a coordinated manner, and encourage and engage in the evaluation of alternatives to facilitate a wider diffusion and implementation of new knowledge, tools and innovations that would otherwise emerge much more slowly from isolated efforts. Bringing together partners who otherwise would not meet, and expanding the flow of knowledge between key actors should enhance the impact of occupational health activities on the health of workers and the industry.

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