

Best Practices for Health and Safety Technology Transfer in Construction

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Background *Construction continues to be a dangerous industry, yet solutions that would prevent injury and illness do exist. Prevention of injury and illness among construction workers requires dissemination, adoption, and implementation of these effective interventions, or “research to practice” (r2p).*

Methods *CPWR recruited participants with experience and insight into effective methods for diffusion of health and safety technologies in this industry for a symposium with 3 group sessions and 3 breakout groups. The organizers reviewed session notes and identified 141 recommendations, which were then assigned to 13 over-arching themes.*

Results *Recommendations included a guide for researchers on patenting and licensing, a business case model, and in-depth case studies including development, testing, manufacturing, marketing, and diffusion.*

Conclusions *A more comprehensive understanding of the health and safety technology transfer landscape, the various actors, and their motivators and goals will help to foster the successful commercialization and diffusion of health and safety innovations. Am. J. Ind. Med. 58:849–857, 2015. © 2015 Wiley Periodicals, Inc.*

KEY WORDS: *construction; qualitative; intervention; technology; knowledge translation*

INTRODUCTION

Construction is a dangerous industry, but solutions that would prevent injury and illness do exist. Prevention of injury and illness among construction workers entails dissemination, adoption, and implementation of these effective interventions, or “research to practice” (r2p). Communication products have been developed and outreach efforts undertaken (e.g., campaigns on nail guns, silica, fall prevention, and heat), yet many research-based solutions that could save lives and protect health are still taking too long to reach critical end-users—workers who would most benefit or contractors best placed to take preventive action [Glasgow et al., 2006; Chen et al., 2010; Wilson et al., 2011].

Getting an intervention from the laboratory into widespread use in the industry requires a number of steps [Rabin et al., 2008]. Diffusion is the passive, untargeted, and unplanned spread of new interventions. Dissemination is active, introducing interventions to a target audience using planned strategies. Adoption is the decision of an organization to commit to and initiate the intervention. Finally, implementation is the process of putting to use or integrating evidence-based interventions within a setting.

Technology transfer, or the process of converting scientific and technological advances into marketable goods (or services), is one approach that is critical for the introduction of solutions for construction hazards. Noise reduction devices, proximity alert systems, and strain reducing tools such as the Inverted Drill Press are examples of successful transfer. The Center for Construction Research and Training (CPWR) launched an r2p initiative in 2010, and as a first step, CPWR conducted a review of completed CPWR-funded research to identify research results ready for implementation on construction sites; a range of barriers to adoption and implementation were identified. To better understand the conditions that support the successful introduction of health and safety technologies in the

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construction industry, CPWR organized, and hosted a symposium entitled *Best Practices for Health and Safety Technology Transfer in Construction* on May 30-31, 2012 (Symposium). This paper summarizes the key point of discussion, themes, and recommendations of the conference.

METHODS

Fifty participants from academia (12), consulting (4), contractor associations (8), government (9), the insurance industry (1), labor (13), and manufacturing (3) with experience with effective methods for r2p of health and safety technologies in the construction industry participated in the Symposium. Prior to the meeting participants were asked to review a literature review on technology transfer and seven case studies of both successful and less than successful development, adoption, and/or implementation of a solution:

1. Residential Construction Safety Rail System
2. The Asphalt Partnership
3. Integrating Health and Safety into Project management Software
4. Successes in Research to practice from the NIOSH Office of Mine Safety and Health Research
5. Inverted Drill Press
6. Business Case for Implementing Battery-powered Tools for Electric Utility Workers
7. Autonomous Pro-Active Real-Time Construction Worker and Equipment Operator Proximity Safety Alert System

The symposium included three group sessions and three concurrent moderated breakout group discussions. The opening session of the symposium reviewed the case studies; the moderator asked the panelists to focus their presentations on three questions:

1. What was the most important factor that helped get your product completed and into the hands of workers and/or contractors?
2. What was the one biggest barrier you encountered during your project?
3. What was a lesson learned from this barrier?

The second group session was a discussion organized by the facilitator around 4 additional questions:

1. How do we identify the right people to be involved in implementing and adopting health and safety technologies across the construction industry?
2. How have you addressed intellectual property issues, including patents, and licensing?
3. Did you develop a business case for your product? If so, what did you include in your cost calculations or return on investment (ROI) ?

4. Did you identify any other important incentives for adoption, such as existing or anticipated regulations, financial incentives, or inherent benefits of safer work?

Participants were then assigned to one of three concurrent, moderated breakout groups, with assignments made to ensure representation from each group in all three sessions. Each group was assigned a moderator and a note taker. Each moderator introduced the same list of questions to each group:

1. Based on the information you've heard so far today, is there one key issue that if overcome, could help move the technology transfer process forward?
2. What elements could be part of a roadmap on technology transfer in construction? Can you think of ways to create a sustainable technology transfer function in the construction industry? What potential roles are there for government (e.g., NIOSH), manufacturers, researchers, end-users, CPWR?

Concurrent breakout groups were used to assess whether similar themes emerged across the three groups. Following the concurrent sessions symposium participants reconvened in a third large group session and reported back the highlights from their individual discussions. These reports were captured by a note taker.

Immediately after the symposium, the organizers identified 13 themes they had heard during the course of the meeting, including themes that had been identified a priori and were addressed in questions to the panelists and the breakout group participants. The organizers reviewed notes to cull out all statements; 141 unique statements were identified. Three of the authors (LW, DR, DW) independently reviewed the 141 statements and assigned each to one or more of 13 themes.

This research was reviewed and approved by CPWR's Institutional Review Board.

FEATURED PANELISTS AND HIGHLIGHTED CASE STUDIES DESCRIPTIONS

Residential Construction Safety Rail System

Dr. Thomas Bobick, Research safety engineer, NIOSH—Division of safety research

To prevent fatalities and severe injuries caused by workers falling through roof and floor openings, the National Institute of Occupational Safety and Health (NIOSH)

worked with residential carpenters to develop a multi-functional guardrail system [Bobick et al., 2010].

The Asphalt Partnership

Gary Fore, TRIAD EH&S, The asphalt partnership

The Asphalt Paving Partnership developed and promoted an innovative, collaborative approach to reducing worker exposure to asphalt fumes, and achieved the universal voluntary adoption of controls on all new highway class pavers. [Mead and Mickelson 1997; Mickelsen et al., 2006; Kreich et al., 2011; Chang et al., 2013].

Integrating Health and Safety into Project Management Software

Dr. Jim Platner, CPWR – Center for construction research and training

Critical path management (CPM) software is used for project scheduling on virtually all medium-to-large construction projects. This effort developed software that would identify worker safety risks concurrent with project scheduling, and therefore allow the contractor to implement controls in advance of an activity to promote safer conditions for workers.

Successes in Research to Practice from the NIOSH Office of Mine Safety and Health Research

Robert F. Randolph, NIOSH

The Office of Mine Safety and Health Research (OMSHR) has an on-going research to practice (r2p) initiative that facilitates the transition of technologies from scientific concepts into solutions miners use every day. Examples include devices that make machines quieter, identify, and mitigate hazardous dust, allow better communication throughout the mine during emergencies, and render potentially explosive atmospheres safely inert [Page et al., 2008; Kovalchik et al., 2009; Michael et al., 2011].

Inverted Drill Press

Dr. David Rempel, University of California San Francisco

Drilling overhead into a concrete or metal ceiling is physically demanding work, and construction workers who frequently perform this task with conventional tools often suffer hand, arm, shoulder, and back injuries. The Inverted

Drill Press allows overhead drilling to be performed from ground level, reduces force to the body by 90 percent, and diminishes fatigue in the neck, shoulders, hands, arms, lower back, and legs. [Rempel et al., 2009; Rempel et al., 2010a,b].

Business Case for Implementation Battery-Powered Tools for Electric Utility Workers

Patricia Seeley, Ergonomics Solutions LLC

Common tasks performed by overhead and underground line workers in the electric power industry often involve the use of manual tools that increase worker injuries and can decrease worker productivity. The case study described how a quantitative business case that supports ergonomic recommendations has been a valuable tool to encourage intervention adoption.

Autonomous Pro-Active Real-Time Construction Worker and Equipment Operator Proximity Safety Alert System

Dr. Jochen Teizer, School of Civil, and Environmental Engineering, Georgia Institute of Technology

When heavy construction equipment is operating in close proximity to ground workers there is a risk of serious injury. The Equipment and Personal Protection Units (EPU and PPU) prototype is a real-time proximity detection and warning system capable of alerting construction personnel during hazardous proximity situations. [Teizer, 2010].

RESULTS

When classifying the 141 unique statements into themes, the three raters had 100% agreement in assignments for 122 of the 141 statements, and 2 of 3 raters agreed on all but one statement. The relative ranking was very similar for the top 5 themes using either 2 or 3 rater agreement; Table I displays the 13 themes, reader agreement, and rankings. Most of the statements fell into the top 6 themes; we then combined the remaining themes into an over-arching area of “external factors” resulting in the following 7 themes.

Identify and Involve Stakeholders

The Symposium participants generally agreed that early and consistent involvement of multiple stakeholders from various types of organizations is essential to the successful adoption of new health and safety technologies; relevant

TABLE I. Themes and Reviewer Agreement

Key Issues	Number of Statements		Number of Statements	
	Related to Terms	RANK	Related to Terms	RANK
Stakeholder Involvement /Partnerships	36	2	48	1(<i>tie</i>)
Usability/Field-testing	24	3	32	2
Business Case	37	1	48	1(<i>tie</i>)
Intellectual Property/Patents	7	4(<i>tie</i>)	7	
Long-term Commitment	6	5(<i>tie</i>)	9	5(<i>tie</i>)
Construction Culture	7	4(<i>tie</i>)	27	3
External Factor A: Macroeconomic Climate	1		2	
Clear Goals	4		4	
Hazard--Focused	0		0	
External Factor B: Regulation/Compliance	6	5(<i>tie</i>)	12	4
Policy	2		4	
Liability & Legal Issues	2		5	
Research	7	4(<i>tie</i>)	9	5(<i>tie</i>)
	Total=122		Total=140	

groups mentioned included researchers, manufacturers, insurance companies, contractors, workers, labor unions, and government agencies.

The presenters for the Residential Construction Safety Rail System and Inverted Drill Press case studies emphasized that early stakeholder engagement helped ensure that the design addressed usability early in the development. In the case of the Safety Rail System, input from contractors and workers generated design modifications that led to several different versions of the tool to address specific roof conditions. Stakeholder engagement in the Inverted Drill Press allowed more than 100 workers to test the usability of prototypes and make suggestions for design improvements; the tool went through five iterations before the final design emerged.

The Asphalt Partnership included diverse stakeholders who would be impacted by the introduction of a new technology innovation. Lessons included the ability of participants to “agree to disagree” about contentious outside issues, an emphasis on openness transparency, and trust, and attention to relationship building and group dynamics early in the process.

Symposium participants noted that the identification of the right partners is a critical component of stakeholder involvement. The Office of Mine Safety and Health Research (OMSHR) has developed their own model for identifying the right partners. OMSHR begins by identifying all of the stakeholders that could potentially be affected by the introduction of the prospective new technology and uses face-to-face meetings to gauge an organization’s interest and commitment to addressing the health and safety risk, and to determine if it possesses the characteristics and capacities desired in a partner—including both problem-solving skills and ample R+D resources. If the candidate organization

seems to be a fitting partner, OMSHR develops a proposal for partnership and presents it to the organization.

Make the Business Case

Symposium participants noted that uncertainty about the return on investment associated with developing or adopting a specific tool is a significant concern for manufacturers and contractors, and that business case studies which demonstrate the financial benefits can influence management decisions to adopt a new tool or technology. Participants noted that industry managers are not likely to adopt a new solution based on injury data and research alone. The Business Case for Implementing Battery-Powered Tools described that in the electric utility industry, a lack of a quantitative business case to support ergonomic recommendations was a frequent reason for non-adoption of interventions. When data were collected on adoption of battery-powered tools leading to increases in electric utility worker productivity those tools were adopted and widely used.

Symposium participants noted that business cases should include information on the marketability of a product as well as information on cost, productivity, and injury reduction. Several participants suggested development of a program where business school students work with safety and health researchers to develop the business case and market research for new products.

Test for Usability

Usability testing and subsequent adjustment in design helps to ensure that tools work as desired. Several of the case

studies highlighted the importance of usability testing in laboratory and/or the field, and the group discussions supported the idea that usability testing is an essential element of technology transfer. Contractors described they are wary of new tools promoted as safer or ergonomic because of prior experience with ones that did not perform as expected.

Access to a testing facility where rail system prototypes could be tested by contractors and workers played a critical role in identifying safety rail design concerns early on in the development of the Residential Construction Safety Rail System. These tests ultimately resulted in the development of several design offshoots to meet worker needs related to various specific roofing conditions. Development of the Inverted Drill Press used 5 rounds of testing while approximately 100 workers (at 80 sites and employed by 30 contractors) field-tested prototype models of the tool and provided valuable feedback. The process allowed construction workers, who will ultimately end up using the tool, to recommend design features that greatly improved the usability and productivity of the tool.

The case study on battery-powered tools for electric utility workers revealed that adopting new tools can result in unintended changes in the way tasks are performed. These changes can impact work organization, workplace culture, and productivity. Participants noted that the tools that experience the greatest rates of implementation are those that do not require radical departure from the way the tasks are currently performed, and do not negatively impact productivity. Participants agreed that field-testing prior to commercialization helps to ensure that a tool works as desired, thus supporting the likelihood of widespread adoption, and implementation. Participants also noted it is particularly important to ensure that the right stakeholders are identified to test the tool/ technology.

During both the group discussion and the breakout sessions, participants recommended using union training centers, which provide hands-on training to apprentices, and journey-level workers, as labs to evaluate usability and productivity. One breakout group participant noted that it is crucial to have the tool representatives go to the training facilities demonstrate the tools and receive feedback. Testing may also be done in simulated circumstances, as in the example provided by the Proximity Safety Alert System case study. Simulating a typical construction environment, experiments identified specific parameters to be evaluated in field testing, including the effects of temperature, humidity, and precipitation; how the device is mounted and positioned on workers and equipment; and the extent to which the weight of the device impacts the worker's ability to perform tasks.

Other participants pointed to the European Union's approach to certification of tools as a model for usability testing. The European Standard specifies a test bench method for the measurement of the emission rate of a given airborne

hazardous substance from machines under specified operating conditions. The measurement of the emission rates serves to: (i) evaluate a machine's performance; (ii) evaluate the reduction of pollutant emissions from the machine; (iii) compare a machine within groups of machines with the same intended use (groups are defined by the function and materials processed); (iv) rank machines from the same group according to their emission rates; and e) determine the state of the art of machines with respect to their emission rates.

OMSHR provided an example of a magnetic mining tool prototype that had worked during computer simulations, but failed when tested by potential end-users. The users were able to provide suggestions for improving the tools that would not have surfaced in a computer simulation. Participants warned of talking about a "great idea" before it is tested and noted that word of failure can go viral, negatively impacting a tool's ultimate acceptance.

Understand the Pros and Cons of Patenting and Licensing

The symposium produced a rich discussion on intellectual property (IP) issues relating to new health and safety technologies. Participants noted that university and government technology transfer offices often prioritize securing intellectual property over goals of spurring safety innovation. This strong emphasis on securing intellectual property can delay commercialization.

The Residential Safety Rail System case study illustrated the rigorous and lengthy nature of the patenting and licensing process, and how it likely delayed introduction of the tool. The design for the Safety Rail System had to undergo a thorough evaluation by NIOSH, and then once the decision was made to pursue a patent, it took four years before the patent was finally issued. An exclusive licensing agreement was established with a manufacturer, but challenging economic times caused the manufacturer to delay production. Recently, the licensing agreement was amended to a nonexclusive status and other manufacturers have started to explore the opportunity to produce the tool.

Some participants agreed that patents create a barrier to commercialization, while others disagreed. A participant noted that companies prefer patents because they provide protection from competition for a limited time. Without exclusive rights to produce the product, the costs and risks associated with making the tool are higher. Symposium participants generally agreed that researchers would benefit from a more thorough understanding of intellectual property, and the pros and cons of patenting and licensing. They should use this understanding to work more effectively with manufacturers to increase health and safety technology transfer.

Be Prepared for a Long-Term Commitment

Technology transfer takes time and funding. One of the cases, the Safety Rail System, has been in the works for at least eight years, and the Inverted Drill Press took four years to test usability and productivity. The Asphalt Partnership took about 12 years to achieve reduced exposure to asphalt fumes on all new highway class pavers. The lesson is that those seeking to develop and introduce new tools and technologies into the construction market should not expect to do so quickly. Many of the elements that were mentioned as those necessary for technology transfer to work—building successful partnerships, performing usability, field tests and making related changes, building the business case for the tool, and getting patents—all require significant investments of time.

The effort to integrate health and safety into project management software for project scheduling is an example where a delay in securing funding resulted in the software becoming outdated before it was ready to be introduced into the marketplace. The case study pointed out that rapid change in software applications and technology need to be considered in the development of a product.

Consider Construction Industry Culture

Much of the discussion of the case studies underscored that the values, norms, and organization of the construction industry can significantly impact dissemination, adoption, and implementation of safety innovations. It was agreed that craft is handed down from generation to generation (either within families or between journey-level workers and apprentices). The resulting sense of tradition can cause workers to resist change, with younger generations of workers often prefer to stick to the proven work practices handed down to them by their predecessors. Construction is also perceived as a somewhat closed culture. A common view held by construction workers is that those who don't "swing a hammer" (or climb a scaffold, or dig a trench) don't understand the nature of the work. As such, respected champions from within the industry play an important role in the introduction and acceptance of new technologies.

Participants also emphasized that construction is generally a highly competitive industry, with many small businesses seeking to maintain a foothold. In this environment, productivity is paramount. Bidding for many jobs a year makes it difficult for contractors to consider long-term return on investments, driving them to focus instead on the short term costs of new equipment. These pressures make it difficult for any one contractor to invest in improvements, unless all of his/her competitors are required to do the same. Furthermore, when a company does adopt a new method that is

advantageous, there may be a tendency to keep the innovation as a competitive advantage, rather than spread the word.

Consider External Factors

Economic climate

Symposium participants noted that the poor economic climate for the construction industry in the period from 2007 to 2012 created an environment where businesses were more reluctant to make investments unless quick investment returns were certain. The company that initially obtained the exclusive license to manufacture the Residential Safety Rail System decided to delay its production of the tool due to the unfavorable market conditions. Participants advised researchers to consider external factors: How is the economy? How dramatically will budget reductions affect development opportunities, both internally for continuing research activities, and externally in terms of a company's willingness to sign a licensing agreement or to agree to a partnership during an economic downturn? Another participant commented that lots of great investment ideas emerge within companies that are not pursued for a variety of reasons, including limited resources, and the poor economic situation only exacerbated the limited availability of investment capital.

Regulations and standards

Existing regulations and standards, or the possibility thereof, are a driving force for workplace safety, and health improvements, but should not be viewed as the only means to achieve safety and health improvements. Participants agreed that, historically, government regulations, and standards have played a significant role in spurring the adoption of workplace health and safety solutions, and are an important part of making a business case. The Inverted Drill Press case study helps to illustrate this point; the California silica standard increased employer interest in new technologies that capture dust emissions and reduce worker exposure to silica as well as reducing musculoskeletal disorders. Concerns about the potential designation of asphalt fumes as a carcinogen and word that OSHA was exploring a new permissible exposure limit for asphalt were drivers for the formation of the Asphalt Partnership. Yet multiple participants pointed out that an approach that relies on the establishment of regulations and standards cannot be the sole driving force for change. The regulatory process in the U.S. is a lengthy one, and therefore cannot be relied on to address workers' immediate safety and health needs.

Recommendations

Several recommendations for CPWR and other organizations to pursue came out of the Symposium. The first was

to develop a guide specifically for occupational safety and health researchers on patenting and licensing. In response, in 2013 CPWR completed work on the *Intellectual Property Patent & Licensing Guide for Construction Safety & Health Researchers and Inventors* [CPWR, 2014]. This Guide, is designed and written to help researchers understand the key steps and questions they should consider, the timing of these steps, the implications of protecting, or not protecting any intellectual property they develop while conducting research, and alternatives to patenting and licensing.

Other recommendations that came out of the Symposium are in various stages of development including:

1. Develop and test a “road map” for technology transfer as a web-based, interactive tool where users access more detailed information, references, resources, and guidance relating to each of the phases of technology transfer.
2. Develop and support the testing of a business case model. Participants recommended that CPWR encourage dialogue between researchers and their business school counterparts at their universities. Researchers could benefit from relationships whereby business school students do market research, help develop a business case, and develop marketing plans.
3. Develop additional, and more in-depth, case studies to capture lessons at each phase of the program from development, testing, manufacturing, marketing, adoption, and implementation.
4. Improve communication between researchers and manufacturers.
5. Look into funding sources that can support the full work that needs to be done to bring a product into use. Participants suggested that there is a need for funding to support not just the developmental research, but also usability, and field-testing.
6. Review European certification systems for engineering equipment to explore implementation in the United States. The European Union uses a test bench to for measurement of emission rates of airborne substances from tools, as described above.

DISCUSSION

Knowledge, time, and money have been invested in safer tools and technologies for construction, yet the investment has not resulted in the adoption, and implementation health and safety specialists have wanted. Prior research supports many of the conclusions of the symposium participants, and may assist in implementation of the symposium recommendations.

Academic studies support the perspective that early and consistent involvement of multiple stakeholders is essential

to the successful adoption of new health and safety technologies [Weinstein et al., 2007; Hess et al., 2010]. Johnson et al. [1997] found that early and regular contact with end users can help to overcome the social, political, economic, personal, or cultural barriers to technology transfer. Reinke and Smith [2010] adds that close interaction between stakeholders during the “development, testing, and refinement of noise controls” helps to address stakeholder needs and helps to provide the industry with “faster access to new controls”. Raesfeld Meijer [2002] points out that successful technology transfer in construction requires the involvement of those who develop, those who build, those who regulate, and those who use a technology. Debackere and Veugelers [2005] notes that technology transfer is strongly influenced by the character and the intensity of the interactions and learning processes among producers, users, suppliers, and public authorities. A number of empirical studies have found that personal communication and networking are among the most important factors for successful technology transfer [Galbraith et al., 2004]. Users express a greater willingness to adopt new technologies when the tool is endorsed by respected fellow workers within their field [Johnson et al., 1997].

Literature substantiates the position that firms are more inclined to adopt a tool when the organizational viability and financial benefits are clearly illustrated. It may be stating the obvious to say that employers will avoid new technologies that require large capital investment (with corresponding benefits), decrease worker productivity, reduce job quality, require frequent or costly maintenance, or change the nature of the job so dramatically that it is assumed by another trade or requires added supervision. Adoption and implementation in the construction industry is more likely if a tool has a relative advantage, is observable, has lower complexity, is usable, and can be tried before purchase [Weinstein et al., 2007]. New technologies addressing musculoskeletal disorders among masons, for example, are more quickly adopted when they clearly demonstrate financial savings in the form of increased productivity, decreased labor costs, or reduced workers’ compensation costs [Entzel et al., 2007]. Similar findings relating to the importance of demonstrating the organizational and financial practicability related to adopting construction-related health and safety technologies have been reported [Pursell 1993; Rogers 1995; Johnson et al., 1997; Stout and Linn 2001], and similar findings have been reported from other industries [Guerin and Guerin 1994; Cain and Mittman, 2002; Coyte and Holmes 2007]. Other studies [Hasle and Limborg 2006; DeSimone and Mitchell 2010] point out that small companies operate under different conditions and resource constraints than their larger counterparts. These constraints make it critical to take limited economic and human resources into account when trying to work with small businesses, again pointing to the need for a good business case.

The importance of usability testing is also supported by research. End users tend to abandon tools that cause discomfort, impede productivity, and/or negatively affect work quality [Kramer et al., 2010]. Studies show the early and continuous involvement of “end users” in the development of new technologies is essential to ensuring that the new tools adequately consider the concerns of the workers [Johnson et al., 1997; Raesfeld Meijer 2002].

In an article on putting academic ideas into practice in construction, Gann notes that “technological progress across the [construction] sector is ...likely to be slow” since companies working in science and technology based sectors typically invest more in research and development than most construction organizations [Gann, 2001]. To illustrate this point the Technology Innovation organization within the Electrical Power Research explicitly plans on a 5–10 year period for technology adoption [EPRI, 2014].

The role of the construction culture as both a barrier and a driver for adoption of health and safety interventions is also described in the literature. The fragmented nature of the industry can inhibit diffusion. Hess et al. [2010] identified regional differences in both benefits and barriers to adopting new technologies for masonry and concluded in some instances dissemination strategies should be tailored to address regional differences even though such an approach is more time-consuming than a national strategy. In addition, the lack of interaction between different trades, subcontractors, individuals working as “independent contractors” is often noted as limiting employer and employee-initiated work-design solutions that might reduce risks of injury [Hecker et al., 2005]. While larger companies are often kept up to date on safety innovation through safety professionals they employ, there is no such mechanism for the vast majority of small contractors who dominate the construction industry. On the other hand, the tremendous mobility of the industry, with workers, and subcontractors moving from job to job, contractor to contractor, provides opportunities to observe and spread innovative practices. A particularly innovative contractor may have a broad influence in this way [Shepherd and Woskie 2010].

Publications confirm that the rulemaking process is too slow to protect workers who need immediate protection from hazards, so technology transfer in the absence of regulation is particularly important to prevent work-related injury and illness. Public Citizen [2011] found that even the negotiated rulemaking process (a process designed to speed up rulemaking) is lengthy. For example, it took 12 years for OSHA to issue the cranes and derricks standard. A 2012 GAO report shows that historically it has taken OSHA an average of 7 years and 9 months to develop and issue a standard, and that it has taken as long as 19 years [Government Accountability Office, 2012].

Weinstein suggests we will have greater success in facilitating the diffusion of workplace solutions if we draw

on theoretical and empirical approaches used in community health [Weinstein et al., 2007]. Kreuter concluded that dissemination will depend on the development of an infrastructure in public health [Kreuter and Bernhardt, 2009]. The findings from this conference will be used to develop tools and processes specifically designed to enhance diffusion in the construction industry.

Building an effective approach for disseminate of research in the construction industry is particularly challenging, however, due to the industry’s complex, multi-level structure (involving general contractors, subs, owners, etc.); its transitory, non-fixed worksites; its preponderance of small, often isolated and under-resourced contractors; its use of low-wage immigrant labor; its lack of unionization in all but the largest sectors of the industry; its deeply held culture of tradition that often resists change; and its emphasis on speed and productivity for business survival [Ringgen et al. 1995a,b]. These attributes result in major challenges that cannot be addressed with a “one size fits all” magic bullet. The building of an effective dissemination infrastructure requires multi-faceted approaches and ongoing learning about what works, when and for whom.

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