THE US DEPARTMENT OF HEALTH AND HUMAN SERVICES
CENTERS FOR DISEASE CONTROL AND PREVENTION

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH (NIOSH)
BOARD OF SCIENTIFIC COUNSELORS (BSC)

SEVENTY-NINTH MEETING
VIRTUAL ON ZOOM, OPEN TO THE PUBLIC
APRIL 20, 2022

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Summary Proceedings

The seventy-ninth meeting of the National Institute for Occupational Safety and Health (NIOSH) Board of Scientific Counselors (BSC) was convened on Wednesday, April 20, 2022 via Zoom. The BSC met in open session in accordance with the Privacy Act and the Federal Advisory Committee Act (FACA).

Attendees

Dr. Lauren Barton – Member
Ms. Anca Bejan
Dr. Jacob Carr
Ms. Dawn Castillo
Dr. Maryann D'Alessandro
Ms. Enjoli DeGrasse - Member
Dr. Cristina Demian - Member
Mr. Michael Foley - Member
Ms. Ruth Francis – Member
Mr. Daniel Glucksman
Dr. Jessica Graham - Member
Dr. John Howard - Director
Dr. Grace LeMasters - Member
Mr. Patrick Morrison - Member
Ms. Emily Novicki - DFO
Dr. Kimberly Olszewsky - Member
Dr. Ketki Patel - Member
Dr. Luis Pieretti - Member
Dr. Tiina Reponen – Chair
Dr. Allen Robison
Mr. Robert Roy - Member
Dr. Judith Su – Member

Welcome and Meeting Logistics

Ms. Novicki called to order the open session of the Seventy-Eighth meeting of the NIOSH BSC at 10:00 am Eastern Time (ET) on Wednesday, April 20, 2022. A roll call of all BSC members confirmed that a quorum was presented. The roll was also called following each break and lunch to ensure that quorum was maintained. Quorum was maintained throughout the day. No conflicts of interest (COIs) were declared. Members of the public were notified that they would remain in listen-only mode until the Public Comment period.

Introductions and Agenda

Introductions

Dr. Reponen asked for everyone to introduce themselves since the BSC has four new members. She is a professor at the University of Cincinnati. She teaches in the industrial hygiene program, and her research is focused on exposure assessment, specifically focusing on aerosols and bioaerosols.

Dr. Barton is Chief Physician at Stellantis Corporation, which used to be Fiat, which used to be Chrysler. She is in occupational medicine.

Ms. DeGrasse is an industrial hygienist with the International Brotherhood of Teamsters. Most recently, she has been researching automated vehicles and robotics in the workplace.

Dr. Demian is an occupational medicine physician, currently with the University of Rochester. On the day-to-day operations, she's the medical director of a small clinic, Finger Lakes Occupational Health Services, which is primarily funded from public money from the New York State Department of Health. And she also is an associate professor with the Department of Environmental Medicine in the very small group of occupational medicine physicians who provide consulting and expertise to healthcare operations for employee health. Recently her research has been particularly focused at return to work and how that is influenced by medical treatment guidelines.

Mr. Foley is an economist in the SHARP program in Washington State Department of Labor and Industries. He previously worked on long-term social and economic burden of injuries. In the last ten years or so, he has shifted to how employment arrangements impact occupational health and safety performance.

Ms. Francis is a senior policy advisor at the American Nurses Association. Her focus area is occupational health, in particular, immunizations, safe patient handling, workplace violence, sharps injury prevention, and anything that impacts occupational safety and health for nurses.

Dr. Graham is an occupational toxicologist, and currently the Director and Head of Product Quality & Occupational Toxicology at Genentech in California.

Dr. LeMasters is an occupational and environmental epidemiologist at the University of Cincinnati College of Medicine, Department of Environmental Health.

Mr. Morrison works for the International Association of Fire Fighters, which represents 326,000 firefighters across US and Canada, EMS workers, paramedics, EMTs. Prior to that, he spent a career as a firefighter in Fairfax County, Virginia, right next to Washington D.C. He oversees health and safety for the IAFF, anything that has to deal with the Fire Service, from equipment to response, to infectious disease, to behavioral health and mental health.

Dr. Olszewski is the newly appointed Associate Dean for the School of Nursing at Bloomsburg University. She currently holds an endowed Professorship of Nursing and is an associate professor. Her background clinically has been in occupational medicine for over 30 years. She's an adult nurse practitioner practicing in the field,

right alongside my academic responsibilities, and is currently President of the American Association of Occupational Health Nurses.

Dr. Patel is a senior manager at the Texas Department of State Health Services. She oversees two federally funded and two state-funded programs: poison epidemiology, environmental epidemiology, occupational health surveillance, and health assessment and toxicology. By training, she is a physician and an epidemiologist, and her area of expertise is occupational health surveillance and informatics, and disaster epidemiology.

Dr. Pieretti is the manager of industrial hygiene for the MEMIC Group. The MEMIC Group is a workers' compensation carrier based out of Maine. Besides being the manager of industrial hygiene for the company, he services policyholders in the state of Florid. In addition, he runs the MEMIC Safety Research Center, which provides grants for safety research. His area of expertise is industrial hygiene, but right now he is very interested about workers comp claims and doing some research about the behaviors. The latest one is about the relationship between workers' comp claims and the average weekly wage of the injured worker.

Mr. Roy is a toxicologist at 3M and has been there for a number of years. He is a professor in the School of Public Health at the University of Minnesota, and part of the Indiana University Graduate Program in Product Stewardship.

Dr. Su is an assistant professor in optical sciences and biomedical engineering at the University of Arizona. Her research expertise is development and application of ultrasensitive sensors for biological and chemical sensing.

Agenda

Dr. Reponen stated that after Dr. Howard's opening remarks there would be two topics being addressed, one about respiratory protection and one about robotics research. Each presentation has a set of questions that the presenters have posed to the Board. She asked the Board members to keep those questions in mind during the talks.

Director's Opening Remarks

Dr. Howard welcomed everyone, especially the new members, and thanked them for their service. I hope the new members can come up with some ideas that they would like to hear about in terms of topics, because we solicit the agenda from members.

We had a little bit of a late budget this year, nearly six months into the fiscal year. And for the NIOSH budget, it was $351 million, which represented a $6.5 million increase over FY 2021, so always happy when that happens as opposed to a completely flat budget or, worse yet, a budget in which we are going in the wrong direction. About $4 million of that essentially goes out the door extramurally, and about $2.5 million stays inside of NIOSH. Unfortunately, we don't have any purely discretionary money—in other words, money that is not assigned to a particular programmatic interest. That's the kind of money that we really wish we had because that allows us to decide where it best fits at NIOSH based on our priorities.

But the outline of the money that we did receive intramurally, we got $0.5 million that helps our National Firefighter Registry, which should be going public this summer into early fall. The other money that is intramural is $2 million that goes to Maryann D'Alessandro's division for Personal Protective Technology [referring to the National Personal Protective Technology Laboratory]. The rest of the money becomes extramural—$1 million for the Education and Research Centers, of which we have 18 throughout the United States; the Ag, Forestry and Fishing, of which we have 10 of those, $1 million; and $1 million for our *Total Worker Health*® Program, which we have a number of *Total Worker Health* Centers.

The budget news is positive. We wait and see on FY 2023, which is coming up in a very short period of time, October 1st of this year. We don't have any information on that now because that is still in review by the Congress.

Dr. Paul Schulte, who was at NIOSH for over 40 years, recently retired as the Director the new Division of Science Integration. It was formerly EID or Education and Information Division, now DSI. Dr. Christine Whittaker is the new Division Director and has been at DSI for many years. She was a branch chief, and some of you may know her from her risk assessment work.

I wanted to give one little update about transition issues. You know, we're hopefully coming out of the very long two-year period of the COVID-19 pandemic, and we're starting to see people return to our physical workplace. And the transition, you know, for NIOSH depends on what kind of work you do. And certainly, this is somewhat simplistic, but I divide NIOSH staff, including me, into three categories.

The first group are laboratorians, and obviously you can't have a mass spec in your kitchen at home. So, clearly, they have really been adversely affected over the last two years by the inability to really do robust laboratory research. We're starting to get those folks back into their labs at various NIOSH sites, and we're really thrilled about that.

The second group, which also has been adversely affected, are field investigators. We've had significant travel restrictions. We could only do travel that was directly related to COVID-19 pandemic response. So, clearly, that interfered with a lot of travel. It doesn't mean that NIOSH didn't do a lot of travel, but we did a lot of

travel to protein processing plants and Indian reservations and hospitals, and all that related to COVID-19. We're starting the transition period to get our field investigators back to work.

And then the third category are people like me that do all their work at a computer, and on digital platforms like we're doing today. Those folks have had to move out of the workplace, usually back to their homes, but haven't necessarily been that much affected.

We're trying to get all three groups back to the workplace. There are a lot of new workplace flexibilities, where not everybody is going to come back to the physical workplace every day. Work has changed. Work arrangements and work patterns have changed. And I think if they're going to have occupational safety and health ramifications—I'm not 100 percent sure we all know what they are—but it certainly is an area of study in terms of remote work and the various issues that come with that, including some very interesting employer monitoring programs that are now available in software on the computer, so the employer can turn on your camera, figure out how many keystrokes you're doing, that type of employee monitoring is new. Also, the issue of promotion bias seen in some psychology literatures, where those folks that are engaging in remote work are not promoted as well as those who come into the office.

The other transition issue I wanted to tell you about is the response itself. At one time in the heyday of the COVID-19 response at CDC, there were over 1,000 people working in the response. Many of those were NIOSH folks that were deployed for various periods of time. Right now, CDC is in the process of restructuring their incident management system, transitioning a lot of the teams back to the home center, institute or office at CDC. The Worker Safety and Health Team, of which we were part of the CDC response for two years, has now been transitioned back to NIOSH.

I did want to point out a couple of things that do relate to the COVID-19 pandemic that have been NIOSH contributions. One is obviously in masking/respirator, and I'll let Maryann take that. But the other has to do with ventilation. And as you've seen from the President's new COVID-19 Pandemic Preparedness Plan that came out recently, research on the value of ventilation in terms of having exposure to exhaled aerosols, that laboratory research came out of the NIOSH Health Effects Laboratory Division (HELD), and we're very proud of that. We're also very proud of the Respiratory Health Division's part of the ventilation team, and also our contributions to EPA's new Clean Air and Buildings Checklist, which is part of that response. Those are two areas that are contributions that are part of the response but may have more lasting value as we go through time.

CDC has started an initiative in health equity, which of course, I'm sure many of you are familiar with the health equity issue from your own perspectives. At NIOSH, our divisions are trying to figure out how we can maximize our research methods, and other activities, to actually promote health equity research.

NIOSH researcher Mike Flynn was the chief author on a recent paper about how we need to expand our research paradigm so that it encompasses the biopsychosocial aspects, a more holistic approach to doing research, as opposed to the purely biological, the purely physical, the purely chemical. And it's a really great paper that's there, I hope that you take a look at it, because I think it's the core of what we have to do in terms of our health equity transition, to be able to more effectively address that issue.

Now, obviously, as you all know, occupational safety and health has been in that area more than perhaps other aspects of public health because we deal with vulnerable workers, the most exposed, the most affected. But it's an interesting area that we're beginning to explore, and I just wanted to bring that out.

Dr. Howard then paused for questions or comments.

Dr. Reponen thanked Dr. Howard and asked Board members to raise their hand or use the chat to ask questions.

Mr. Morrison thanked Dr. Howard and applauded the NIOSH staff. He asked a clarifying question about the budget: Is that just how the budget plays out, that you cannot actually put in money for what you'd like to do; you have to assign a project to get that funding for that? You said all the money coming in basically is assigned to project work.

Dr. Howard said historically it's probably the word "earmark" people are more familiar with. For few years there, the Congress actually outlawed earmarks, which was interesting, but they're now back to it. And that means that the money that we've gotten in this budget is attached to a program. We don't have any discretion to take that $6.5 million and spend it the way we want. It's earmarked to specific programs so that it takes the discretion away from us.

Money that is not earmarked, that is supplemental to our budget, allows us to say okay, well, we've got some priorities ourselves that we've worked out. We'd like to spend more money on AI. We'd like to spend some more money on robotics research, on motor vehicles, on chemicals management, whatever. We don't have that discretion. So, within our own budget of course, we do, but any additional money usually is earmarked. One of these years, we'd like to have them put a couple of million in and allow us to be able to allocate it to our own internal priorities, but not this year.

Mr. Foley stated that his agency in Washington State will submit budget requests tied to specific projects going forward that they'd like to do. Is anything like that happening? Does NIOSH have a list of candidate projects that it would like to do that they then put forward to the budget-writing committees?

Dr. Howard said yes, indeed. We do that every year. It goes to CDC, it goes through HHS, it goes to OMB. OMB prepares the President's proposed budget. The President's proposed budget was pretty flat, so we considered the $6.5 million that we got to be actually a win for us, and it has to do with the fact that every President proposes a budget and usually it's voted down almost immediately because the Congress takes great pride in the fact that they are the ones that appropriate money to the Executive Branch, not the other way around. So it's the appropriators that do that, and our stakeholders are very good, very efficient, very capable at going to the Hill and making sure that their interests are represented. That's the system.

Mr. Morrison: And what is coming up in the future, do you think?

Dr. Howard: I'm not sure about next year. One of the issues that happened this year is the Congress was scrounging around for any funds that were not attached to an earmark. We may have been under consideration for some unattached money, but they ran around trying to find every dollar that was not

attached to a member's request in order to put it into the Ukraine budgetary issues. Maybe next year will be better.

Dr. Reponen: While waiting other questions, let me ask about looking at the list of the budgetary issues, the last one was analysis of the impact of COVID-19 in the workplace. Could you maybe go into more detail on what is that entails?

Dr. Howard: Yes, so that's not a budget issue per se. It goes in the conference committee report which goes along with the Consolidated Appropriations Act. And what it does is say you, NIOSH, should do the following, and the HHS, CDC and NIOSH, we honor that request. One of the big issues that happened during the pandemic is everybody wanted to know what is occupationally transmitted and what is community transmitted. So I have all of these wonderful, intelligent epidemiologists on the BSC listening to me, and I don't think I have to tell you guys that that is very difficult to sort out because, unless you're dealing with a bunch of workers that are cloistered in a workplace and never go home, never go to their family, never go to a restaurant, never go to a concert, never go to a movie theater, never do anything else in which they could be exposed to COVID-19, it's very difficult. And so what you have is a great interest on the part of folks in trying to disentangle that transmission chain from the workplace to the community, and it's frustrating to a lot of us. Now, we've been able to see it a little more, and some surveys have been done. Our group has even published some work in that area, in healthcare workers for instance. But generally, it's a tough question, and the Congress said: you should try to solve it, and you should do a report in 180 days. We're working on it, trying to satisfy that request so to speak. But as every epidemiologist on this call knows, it ain't easy.

Dr. Reponen: So no additional money, just more work.

Ms. DeGrasse wanted to ask a question on the health equity research by Michael Flynn. I know that I'm partnering with him within the AIHA organization on looking at health equity relative to the practice of industrial hygiene. We also, last year, published our work on health equity in AIHA's journal. Just wondering if NIOSH is also funding research within this new arena.

Dr. Howard: Well, it's a great question, and certainly we would be very interested in that. As you know, we do, three times a year, investigator-initiated research grants, and health equity is a topical area that we'd like researchers to pay attention to. So that's something that you may want to have Allen Robison, who's on the call, address that a little more. But I'll say that we're interested in this area. It's a big issue for not only CDC and HHS but for the Administration. And I hope that—and thanks for working with Mike and others on this issue—and I hope people read Mike's paper, "Health equity and a paradigm shift in occupational safety and health." It's really a super great paper, and I think it really helps us understand where we have to get to in terms of health equity research. We have to expand our focus into this biopsychosocial paradigm that Mike and the other authors wrote. But I'll ask whether Allen, who's on the call, can address the issue of health equity within the extramural community.

Dr. Robison: Within CDC there is a new effort to put together a health equity funding opportunity in the Small Business Innovation Research arena. They have a fast timeline. They've been thinking about it for a bit, there's some possibility there. And then, associated with that, a lot of people in NIOSH were interested in this

topic, and at some point, NIOSH would like to have an extramural funding opportunity announcement in this area, but we're not quite at that point yet. And, as Dr. Howard mentioned, there are many competing priorities for extramural funding. But we definitely have the interest, we have a lot of good information and material that would go into such an announcement.

Dr. Patel had two questions. The first piggybacks on the analysis of impact of COVID-19 in the workplace. That one mentions about data collection. So, is it primarily asking NIOSH to prepare a report based on data or research done by NIOSH, or is that on what NIOSH was able to collect from local and state jurisdictions about COVID-19 infections and outbreaks, and based on that information, prepare this report?

Dr. Howard: I think honestly, we would take all the information that is available, internationally speaking, and try to answer this question. It would be work that we've done, of course, because we've done work during the response. We have several occupational epidemiologists that have worked in this area. Marie Haring Sweeney, our branch chief in the Division of Field Studies and Engineering (DFSE) and who you know. But we would try to sort of do a metanalysis, so to speak, trying to bring all the information to bear on trying to answer the question.

Dr. Patel's second question relates to the bullet point on Agriculture, Forestry and Fishing in the budget section. It mentions about an increase to expand efforts. Now, is that in relation to intramural or extramural efforts and, if it's known, what kind of efforts are we looking at?

Dr. Howard said it would be extramural. We don't have any intramural activities going on in Ag, Forestry and Fishing. We did historically, and it really wasn't efficient for us to do it. You know, we use an analysis where we decide, are we best at doing that, or is someone else best at doing that? We decided that the extramural community is much better, and that's why we have ten Centers for Agricultural Safety and Health (Ag Centers) today—very productive. So that's all extramural. And then, they work with our Associate Director for Ag, Forestry and Fishing, Jennifer Lincoln, to work out, okay, we have this million dollars and then that's going to go out the door to those ten. That's going to be about $100,000 if you just do it that way. It's not a lot of money but it helps mostly, I think, augment existing projects that they may be doing. $100,000 is probably not enough to really get a good budget going but it certainly can augment something that they have going.

Dr. Reponen asked what is the current allocation for investigator-initiated grants, and then what's the success rate for those grants?

Dr. Robison said he would find those number and share them later. The success rate is a low percentage. [Note: later in the day he shared the webpage https://www.cdc.gov/niosh/oep/fundingsummary.html]

Ms. DeGrasse wondering if there had been any HHEs relative to COVID exposure requested?

Dr. Howard: There have been quite a few, especially in the early days, starting in March, April, May, June, July of 2020 we visited many pork, beef, turkey, whatever protein processing plants in all of the United States, and several HHEs came out of that. So those, those are all on our website, and you know, take a look at the HHE program there. But that was a huge effort in 2020 for us in the HHE program.

Ms. DeGrasse: Are you ever successful at getting HHEs done at sites without employer buy-in?

Dr. Howard: It's more difficult, clearly. The easiest route is when employers and employees both agree we need to have NIOSH come in, it's an important research issue, we don't understand and we want to solve it. When there's friction between the two, it becomes more difficult. Not impossible but it's certainly more difficult.

Ms. DeGrasse wondered about that relative to heat. I know there's a big heat injury and illness initiative, and there are facilities, especially in Region 5 I believe, where there's the NEP region, NEP I think, down Texas area. Maybe it's the wrong region number. But I'm just wondering if that could be supported, HHEs could be supported, with or without employer buy-in.

Dr. Howard: Yes, it is something to work on. The other thing you should remember is that the HHE program, tries to orient itself to real research questions. You know, I think we know what heat does and we know how much heat is bad. It's not a new research issue that we need to uncover, so it's a little different than some of the others. It's like indoor air quality. For years, NIOSH did hundreds of indoor air quality, and finally we realized we know all the answers. Whether somebody is actually doing what we say is a different thing. Heat is an important issue. OSHA's concentrating on it, and we're happy to support them in that area. But an HHE for heat, especially in the external environment, you know, it's not a brand new issue. It's a struggle of course and, as you say, workers are exposed and we need to protect them. But it's not, you know, an issue that the HHE program, as a frontline research agency division, is necessarily trying to figure out.

Ms. DeGrasse: Okay, right. I know that the indoor heat is being looked at more closely, so that's what I wondered, in being that trucks, I guess, depend on the definition you look at is considered an indoor work environment.

Dr. Howard: Yes, indoor is a different kind of heat stressor, definitely.

Dr. Patel: As you all can see, I belong to more of the younger generation of the workforce so I'm always curious to see, you know, how government agencies are trying to reach all the different masses, to use media communications and social media, and I see the update on probably page number 11 of the talking points. My question is: are there any special allocations for strategic methods that NIOSH is currently exploring to expand its presence in the media world? Because, you know, over the course of the pandemic, I guess that was the mainstream to get the message out to the people, where you couldn't go in the field, talk to workers, talk to people or whatever. And if you could just expand out on that a little bit.

Dr. Howard: Yes, it's a super great question, and I think it might be worth bringing our Associate Director for Communications, Christy Spring, and her team to present and get into some of the depth of those issues in terms of communications targeting, because that's a real struggle that we've had for any number of years is getting people to pay attention to us. Although, I must say that lately, in the last five to ten years, it's been a lot easier in terms of a younger worker, because they're more attuned to social media channels, and we've been able to use every social media channel that's available, we just jump into it. Our Twitter feeds and our Facebook feeds and all that have been, I think, demographically pointed in the direction that you're talking about. I don't know the stats for that, and that might be something to explore. We haven't done a communications presentation in recent years. I think it's overdue in that respect, and I think what you're

raising in your question I think could be very interesting for us all, because it is changing. Because of social media channels, I think we're better off at the younger age than at the older age group.

Dr. Patel: Right. The whole rationale behind this conversation or question was, over the course of the pandemic, we've seen these things go both ways—one, how important it is to have a platform to reach out to people to get the right message; and how to use that to, for a variety of things, to improve our outreach, to improve our messaging, or even for surveillance purposes.

Dr. Howard: From the CDC perspective, trying to overcome some of the misinformation issues with regard to COVID-19, there certainly has been a struggle in that area. And I think what CDC is trying to do now is that transition from the government talking head kind of thing, to finding people that people actually listen to, whether it's their doctor, their pastor or whatever. I saw an HHS commercial on TV the other day that didn't have any government people at all. It had just regular, I think it had a doctor and I think it had a minister or something on it. I think there's some literature on how to do COVID-19 communications better. So that would be something that could be clearly, something that in safety and health we could learn about what's happening in that area too. So, great question. We'll have to put it on our list of topics.

The Evolving National Landscape for Respiratory Protection

Presentation

Dr. D'Alessandro: Good morning, everyone, and thanks for having me today. It's a pleasure to be able to present the evolving national landscape for respiratory protection. Over the past 20 years, the landscape has been shaped primarily by public health emergencies, including COVID-19, and further emphasis on equitable PPE, including respiratory protection for all workers in recent years and those not covered by OSHA respiratory protection programs. And especially throughout the COVID pandemic, and even prior, there has been a growing interest in respiratory protection for the public, so due to the issues such as wildfire smoke, pollution for workers and family members overseas—the State Department has a big interest there—and then the potential for airborne hazards when in close contact with those who may have an airborne infectious disease. This presentation has two major focus areas: what we are doing now, and the very important National Academies report.

I will start with an overview of the current respiratory protection landscape, and next I will talk about emerging issues and recommendations, and the recent National Academies report that identifies both worker and public needs, and have the potential to impact our future roles in this space; and also, I will talk a bit about how they tie in with the federal efforts underway at the national level. And as you learn how these areas are being coordinated and how the landscape is evolving, I would like your perspectives on what additional actions are needed by NPPTL, and I have that framed in the three questions at the end.

For those of you aren't aware, NIOSH NPPTL was established in 2001, and our mission revolves around personal protective equipment—specifically, advancing the state of knowledge and application of personal protective technologies. Now, we are a division in NIOSH with about 130 federal and contract staff, and our key responsibilities include respirator conformity assessments, which includes the Respirator Approval Program, and also post-approval activities; PPE research where we currently emphasize respirator and protective clothing research; and PPE standards development and translational science, including workplace interventions.

As most of you are aware, at NIOSH, we approve all respirators used in U.S. occupational settings, including healthcare. And this framework for respiratory protection is based on the Occupational Safety and Health and the Mine Safety and Health Acts, and has evolved since NIOSH took the responsibility in the 1970s. After NPPTL was established in 2001, and more recently with COVID-19, the expectations on us have increased substantially.

Since 1972, we have about 9,000 respirator designs that have been approved by NIOSH and, typically, the Program has about 90 manufacturers that are issued a NIOSH certificate of approval, with approximately 120 manufacturing sites located in 25 countries. Our approval process includes both physical testing and a rigorous quality assurance review, and the manufacturer has to have a comprehensive quality plan in place. And our most recent regulation incorporated a site qualification as part of the approval process. This addition helped us to overcome some of the time that was taken when approving a product and then conducting an audit afterwards, and learning that the manufacturer didn't have everything necessary in place. It helps those players not get in the market when they shouldn't be in the market.

You can see our conventional numbers and our COVID-19 numbers, and the productivity has increased substantially over the past two years. We typically approve about 65 applications—30 application decisions per month, and we did 65 throughout the pandemic. And you can see we do 400 typically, and 800 and 732 over the past two years. And then 250 audits, 781 in 2020 and 260 in 2021. That large number of audits in 2020 was a result of an international assessment activity we took on to evaluate international respirators. There were a lot of claims about counterfeit and substandard products that were being able to be used. And through our evaluations, we showed that more than 60% of those products did not meet the expected requirements.

This issue of counterfeit and substandard is now a major activity for us. Our work with international respirators showed us that more energy needs to be put toward counterfeit and substandard respirators. At this time, it seems that additional resources will be needed to effectively address this area, and the development of processes and enforcement around counterfeit respirators. Currently, the activities we are working on are all within the constraints of our existing resources.

Prior to the pandemic, we did not have any of our marks such as N95 registered, and with the overwhelming amount of products coming into the country that would be just labelled N95 and no one could know whether or not it performed at all anything close to an N95, we made a decision that we would register the NIOSH stylized logo, with and without words, "NIOSH Approved", "N95", "N99", "N100", "P95", "P100"—and all of those have been registered with the US Patent and Trademark Office, and also registered with the Customs

and Border Protection, who we are working closely with as products are coming into our borders, and they are looking to see what types of products are coming in and how we can work together most effectively.

We have put out some notices, a NIOSH Counterfeit/Misrepresented Respirators webpage that is up there and has been the second most viewed webpage in 2021. We are working with the National Institutes of Health (NIH) on all of these trademarks that are still pending in the U.S., but then also in 18 other countries. To date, there have been 4 granted in other countries, and "NIOSH Approved" is being registered in 16 countries and it has been approved in 6 so far.

We are working with the Customs and Border Protection to provide them information they need, as I mentioned, to stop the products at the border, and we are exploring certification mark monitoring tools, and had a recent contract with Underwriters Laboratory (UL) to learn from their experiences in this space. They've provided some great recommendations for us, and we are starting to implement those now. These monitoring efforts are critical to maintain the integrity of the marks, and this is something we see as an ongoing activity.

And because of this increased workload and a lot of other areas I didn't mention yet, we are looking at how we continue our productivity that we achieved during the pandemic and not burn out our staff. And essentially, we are looking at how we align with the National Conformity Assessment model, and how it can be applied to PPE within our core functions.

Our NIOSH framework was published in 2015 and it talks about the steps needed to achieve conformity assessment, and each of the components here in the bullets that you see are very important to optimize. Throughout the response, we have had to modify our prioritization based on the political climate and user needs. We've had to keep pace with user needs and manufacturer demands, explore alternative approaches to doing business, and some of the explorations that we have underway are looking at the use of third-party labs in the Program when demand exceeds our capacity, and also to support innovators who may be going through the process that I'll describe later. Use of remote site audits when travel is not possible—we initiated use of remote site audits with the technology we had during the pandemic, but there is a lot of technology out there that we could possibly optimize. We're exploring that. Updating our standard test procedures— in some cases, our approval program is using 30- to 40-year-old equipment while manufacturers developing products have more contemporary equipment. We need to update our equipment to keep pace with this contemporary technology. And, of course, addressing the counterfeit respirators and protecting the N95 brand.

Another issue is that we do not have an applicant qualification scheme. Anyone can submit an application and become an approval holder and triaging these applicants' requests has been quite a learning experience. Prior to 2020, we didn't have a triage process. We had about 5-10 new applicants come in a year—that's from someone who had never been approval holder in the past. In 2020 we had over 1,000 come in, and in 2021 we had hundreds come in. Managing those requires processes that we didn't have, and we're working on those now.

Additional conformity assessment analysis skills are needed to optimize all of these processes, and we're exploring these processes to have this qualification scheme. All of these efforts will impact our operations moving into the future. While we conduct our day-to-day operations, continue to do that in parallel, we have these strategic efforts underway to see how we can move the needle to be more contemporary on some of the things that we do.

One of the greatest achievements during the pandemic was the research we conducted that showed that both inhalation and exhalation breathing resistances could be met with the elastomeric half-mask respirator (EHMR) when exhalation valves were closed. This work prompted manufacturers to address the source control concerns, and we now have about 13 new products that are approved—EHMRs without exhalation valves—and one manufacturer with a filtered exhalation valve. A number of research activities are underway to support future improvements to the approval process, including decontamination techniques for those reusable products, and looking at the utility of elastomerics and powered air purifying respirator (PAPR) use in the sterile field and throughout healthcare.

From the strategy perspective, for the past 13 years we have established action plans or targets for PPE in healthcare. This third plan that we have just developed is focusing on the years 2020 to 2030, and it focuses on six particular areas. This plan will be posted our website soon, after a federal register notice is published announcing its availability.

One key area we have catalyzed is the elastomeric respirator area. We initiated multiple clinical research studies prior to the pandemic, and continued them throughout and expanded upon them, looking at EHMRs with just-in-time fit, disinfection, long-term routine use in healthcare, and these efforts informed the use of EHMRs in healthcare and led to the development of best practice guidelines with two of our partners, the University of Maryland—who had been using elastomerics in healthcare for over 15 years—and then Allegheny Health Network right here in Pittsburgh, who actually shifted their entire staff from using filtering facepiece respirators to solely using elastomeric respirators during the pandemic. Each of these partners developed a best practice guideline that they use in their sites, and then we are taking those two tools and working on developing national best practices with all of our research outputs, their two best practice guidelines, and a number of other efforts we have going on. It's a very exciting endeavor that I think will be very valuable for the healthcare and the EMS community.

Our efforts to address equitable PPE for all workers was initiated in 2020 and is an iterative six-step process. During the first step, we are documenting what the issues are associated with equitable PPE for all workers. Following many conversations with relevant key players across the sector, we launched a federal register notice to solicit public input on research and practice gaps related to equity of PPT protections for all workers, and the federal register notice received 39 responses from very diverse sectors and populations. We have been presenting the results of this Notice and the comments to National Occupational Research Agenda (NORA) councils and partners such as the International Safety Equipment Association and our National Academies Committee on PPE, and also, we are conducting literature reviews to further expand on what we've learned through the federal register notice. We saw this work as a well-time opportunity to create change reflective of CDC and NIOSH's commitment for diversity, equity and inclusion within large-scale

strategic research and practice initiatives, with the high potential for future impact, both within and outside of CDC and NIOSH.

We now are identifying and organizing our collaborators across the PPE community, and in summer 2022 we have a crowdsourcing challenge that will be initiated, followed by a workshop in the fall that will help to further prioritize gaps and lead to a framework to address those gaps and expand our research portfolio in this space for respirators as well as other types of PPE. A roadmap is going to then be established, with timelines for the gaps and linkages to the PPE community members, and we will develop metrics for success as well.

Another effort underway that is expected to accelerate PPE basic and intervention research is the launch of the PPT Centers of Excellence (CoE). In 2008, these CoEs were recommended when the PPT program was reviewed, and we initiated activity but did not have funding to pursue them. We put a stop to the work that was underway and pursued some other efforts through contracts. Early in 2021, there was some talk of potential funding and with the national PPE interests, we reinvigorated this topic and initiated discussions with potential CoE partners to get their ideas on the gaps and needs. And we then published a federal register notice to solicit stakeholder interest on what the CoEs could include. We received 46 comments, and those comments are helping to frame the CoE concept if funds were to be made available. We're linking these comments with those comments from the federal register notice on equitable PPE for all workers.

The respiratory protection landscape has evolved over the past 20 years. When NPPTL was established in 2001, just before 9/11, the emphasis was on standards and research for emergency responders and miners. The mine disasters in the early 2000s emphasized the need for improved standard for closed-circuit escape respirators, and both chemical, biological, radiological and nuclear (CBRN) and closed-circuit escape respirators (CCER) standards were under development, and efforts to continue to update and improve these requirements continue today.

In the early 2000s, the threat of pandemic flu prompted the National Academies to recommend that we explore efforts to look at respirator and PPE needs to prepare for a pandemic. These studies were followed by more focused efforts on elastomeric respirators and PAPRs that paved the way for the research agenda where respirator reuse, decontamination, and stockpiled respirators were explored and provided in the guidance throughout the pandemic. The research conducted in the early 21st century through 2020 served as the basis for many of those recommendations.

For the past 15 years, the National Academies' studies and recommendations to enhance worker protection, and respirators and respiratory protection against inhalation hazards such as wildfire smoke, mold in floods, and infectious diseases has also been part of the effort, but these efforts all fall out of NIOSH mission as defined in the Occupational Safety and Health Act and the Mine Safety and Health Act.

These reports, which just came out in 2020 and 2021, have a public spin and make a lot of recommendations. They're very timely reports, as there is a national emphasis on respiratory protection for workers and the public, and the national emphasis is in this National Strategy for a Resilient Public Health Supply Chain

Now I'm going to spend a bit of time talking about this most recent report and its recommendations, followed by the National Strategy efforts and what is going on there, how we had a role, and what other efforts are underway.

Four years ago, NPPTL initiated discussions with the National Academies Committee on PPE about respiratory protection for the public and workers without respiratory protection programs. We had been getting a lot of inquiries during the wildfire seasons, also when there were situations from natural disasters, where there were floods and mold issues, and the EPA and the State Department also were interested in these areas of research and respiratory protection standards and use needs.

We initiated a workshop that was conducted in the summer of 2020, which was very timely because we were able to tie in COVID-19 with that. Initially that wasn't part of the plan. And then, after that workshop was completed, it served as an input to a larger consensus study we were able to initiate with those same partners, as well as with the CDC Foundation, who provided COVID-19 funds because of the respiratory protection concerns for the public during the COVID-19 response.

The recommendations and the consensus study report were delivered in February 2022, and the report has three overarching recommendations: one focusing on workers, one on the public, and one coordinating between the two.

In their report, they describe a framework that includes six components. It is like the industrial hygiene hierarchy of protection model, or the NIOSH PPE Conformity Assessment framework mode. This model is to be used systematically to link PPT technologies with users. Ultimately, the framework reflects the need to have products that conform to appropriate standards, use conditions, and based on the hazards and access to the PPE, and continuous improvement, and effective coordination.

Figure 1. Model from *Frameworks for Protecting Workers and the Public from Inhalation Hazards*

Each one of these six functions could have a lot of subfunctions associated with them. For example, F2 is not only dealing with the identifying the hazards that come out of F1 but all the conformity assessment requirements that are needed, including user instructions, labeling, and embodies several steps from our framework that falls under F1. There is a lot of work that has to be done to align this framework with PPE and

where we need to go. Also, F4's category to engage, inform and ensure access for the target user community, it's not just about providing access to the PPE, you need to have the appropriate user instructions associated with this function. There is a lot of additional work that needs to be done to support these functions. They might look like they are highly focused functions, but in fact they are very broad categories and we have a lot of work to do to determine how this will be executed. Ultimately, this is a systematic approach to ensure that respiratory protection that is worn is used in an appropriate way.

The National Academies' framework from the previous slide is very similar to what NIOSH published in 2015, and that is the NIOSH Conformity Assessment Framework, and it is more specific in addressing the National Academies' F0, to develop and approve devices; and F1, to assess the hazards; and F2, to determine the necessary respiratory protection devices (RPDs). But this framework is what we use when we're looking at our approval program and all PPE activities include conformity assessment activities.

The report provides a set of recommendations for applying the framework to meet the respiratory protection needs of workers, which is 6-1, and a set of recommendations to meet the needs of the public, which is 7-1, and recommendations calling for collaboration between the two efforts. There are five overarching recommendations for workers and there are four overarching recommendations for the public. I want to spend a bit of time now digging into these recommendations a bit.

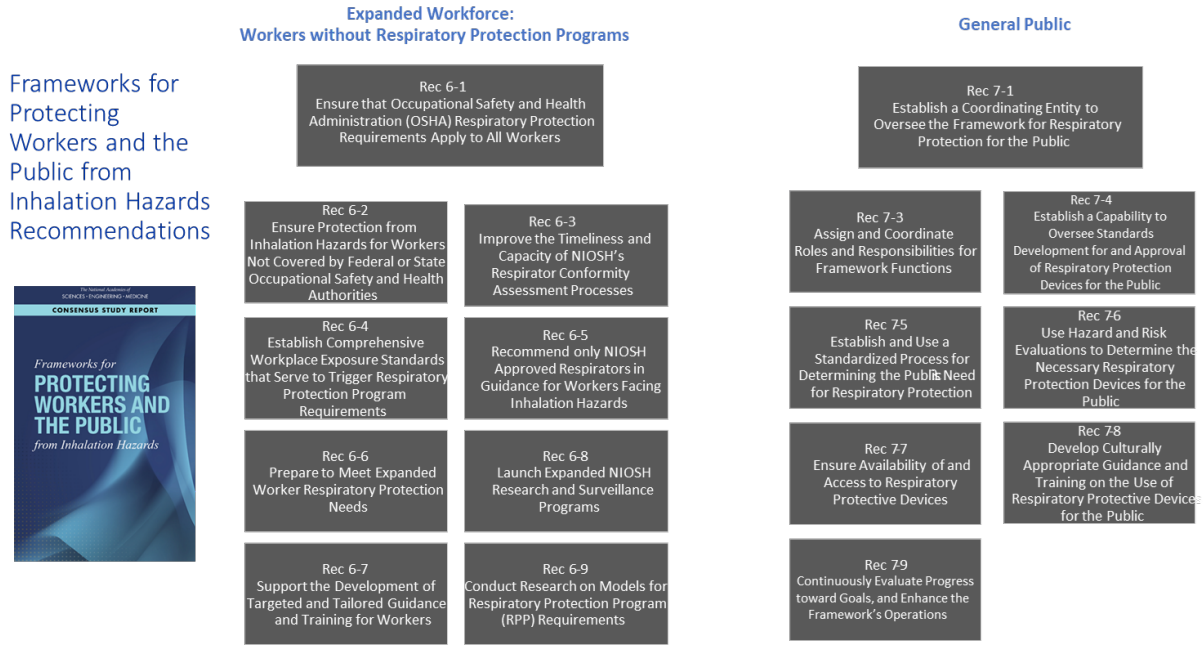

Figure 2. Recommendations from *Frameworks for Protecting Workers and the Public from Inhalation Hazards*

Three recommendations under workers are led by OSHA and states, Congress and the focus is on ensuring protections from inhalation hazards for all workers. In 6-1, they ensure that Occupational Safety and Health Administration respiratory protection requirements apply to all workers. And they talk about Congress revising the OSH Act to address gaps in OSHA coverage, and OSHA revising its statutory interpretations regarding definitions of employers and employees. In 6-2, ensure protection from inhalation hazards for workers not covered by federal or state OSHA authorities. State legislators should require employers to

protect workers who are not currently under OSHA jurisdiction for inhalation hazards, through legislation and regulations.

Then under 6-4, they should establish comprehensive workplace exposure standards that serve to trigger respiratory protection program requirements. And here, they talk about Congress setting deadlines for OSHA's promulgation of these standards, OSHA expanding its technical assistance capabilities to assist employers unfamiliar with RPP requirements, and OSHA and NIOSH developing comprehensive guidelines for workers who are high risk of exposure to these hazards in the interim, to make sure those needs are met.

There are two recommendations focusing on generating and using NIOSH-approved RPDs. 6-3, improve the timeliness and capacity of the NIOSH Respirator Conformity Assessment Process, where NIOSH should expand NPPTL and use consensus standards and third-party testing to improve timeliness of respirator approvals and surge capacity. And 6-5, looking at recommending only NIOSH-approved respirators, and guidance for workers facing inhalation hazards. Agencies providing guidance for workers should recommend only these NIOSH-approved devices.

The next category is meeting expanded worker needs for device access, guidance and training on use. In 6-6, prepare to meet expanded worker respiratory protection needs, where OSHA and NIOSH should evaluate expanded worker needs for respiratory protection and guide the Office of the Assistant Secretary for Preparedness and Response (ASPR) on stockpiling and distribution guidelines. In 6-7, support the development of targeted and tailored guidance and training for workers, where OSHA, NIOSH, EPA and other federal agencies should expand grant programs and other support mechanisms for the development of tailored and culturally appropriate guidance and training materials for employers and workers.

Two recommendations focus on building a strong scientific foundation. 6-8 is launch expanded national NIOSH research and surveillance programs, and here they talk about NIOSH expanding its surveillance of intramural and extramural research programs to better understand risks to workers from inhalation hazards, and to advance the development and effective use of respiratory protection. And then Congress should ensure the necessary appropriated funding. These are gaps that we have been exploring for many years but there hasn't been a lot of dedicated funding associated with exploring those gaps.

Then, 6-9, conduct research on models for respiratory protection program requirements. NIOSH should assist OSHA in evaluating the effectiveness of different respiratory protection program (RPP) models and RPP requirements for different scenarios for occupational exposure to inhalation hazards. So, for those workers who do not have a standard respiratory protection program, is there something else that could be provided to them that would better suit their needs, and NIOSH working with OSHA to help identify that is a priority.

Now let's take a look at the recommendations for the general public. First, there are two recommendations focusing on establishing authorities and mechanisms for coordination, and that's recommendations 7-1 and 7-3. 7-1 is establishing a coordinating entity to oversee the framework for respiratory protection for the public. Here, they talk about Congress establishing a coordinating entity within HHS, with the necessary responsibility, authority and resources to provide a unified and authoritative source of information, and effective oversight of RPDs for the public, and that HHS should establish an interim office to take on priority

near-term tasks of this coordinating entity, and that the White House should establish an interagency taskforce to ensure coordination. Incidentally, this effort was something that was started in the fall, and it aligns pretty closely with what is recommended in 7-1. The terminology is not exactly the same and there are a few other objectives, but it's very interesting how it aligns quite well with what this recommendation is.

And then in 7-3, assign and coordinate roles and responsibilities for the framework function. The coordinating entities should assign and organize roles and responsibilities of federal and other stakeholders, and Congress should address the gaps in authorities. There are clear gaps in the authorities. NIOSH is responsible for respiratory protection in occupational settings. There's no one responsible outside of occupational settings. We feel, as part of CDC, we can have a role in this space, and we'll talk about that a little bit more.

There is one recommendation that focuses on establishing an oversight authority for the devices and the intended for public use, and the report recommends that that capability oversee standards development for and approval of RPDs used by the public, and that Congress should mandate that HHS establish and resource a lab responsible for overseeing standards development, conformity assessment, and approval for RPDs intended for use by the public. And they say it could be NPPTL or it could be a new lab within HHS.

Our feeling is that, you know, we have these responsibilities for the workforce, we have the expertise, we have the responsibilities, we have the national capacity in this space. To us, it makes sense that we could take on those responsibilities, of course not with our current funding levels. It would need additional capacity.

The next two recommendations, 7-5 and 7-6, emphasize the need to evaluate hazards and identify the devices that need to be used for the public. Establishing and using a standardized process for determining the public's need for respiratory protection, so this is something that the coordinating entity would do, working with CDC, EPA and other stakeholders to apply a standardized scientific review and evaluation process, to identify inhalation hazards that warrant public use of RPDs. The hazard assessment that we do in the workplace, how do we do that same type of thing for the public?

And then 7.6, use hazard and risk evaluations to determine the necessary respiratory protective devices for the public. The recommended lab should make recommendations to the coordinating entity on approved RPDs that best meet the needs of the public based on hazards, risks and evaluations.

Recommendations then follow on ensuring device availability and access, and developing appropriate guidance to support the device used. The coordinating entities should organize efforts to make RPDs available and accessible to the public, interfacing with ASPR, OSHA, FEMA and the White House to ensure adequate supplies are available. And then CDC should lead the development of culturally appropriate guidance and training related to the use of these products. And the coordinating entities should facilitate the engagement of gathering this input from stakeholders.

And finally, the last recommendation for public use is ensuring continuous improvement. The coordinating entities should, based on ongoing monitoring and evaluation, develop plans with objectives and milestones, regularly assess and publicly report on progress, ensure funding allocations, enable goals to be achieved,

coordinate linkages across partners, conduct periodic exercises to evaluate preparedness, and lead the development of a strategic research agenda.

There is one recommendation that I mentioned, that coordinating between the worker and the public, and with that, OSHA and HHS should ensure that mechanisms are established to support collaboration and cooperation as the two frameworks are implemented, and this should include, among requirements for regular assessment and reporting about the progress being made.

This is a lot of information to take in and very complicated, requiring congressional legislation in some cases, and additional authorities in others. Still, there are worker and public needs that must be addressed, and we have been working at the highest federal levels in these areas. I've taken the liberty to categorize the recommendations in three areas. Those items led by other federal agencies are in blue. Those items that NIOSH and NPPTL should support are in brown, and those items I believe require immediate action are in green.

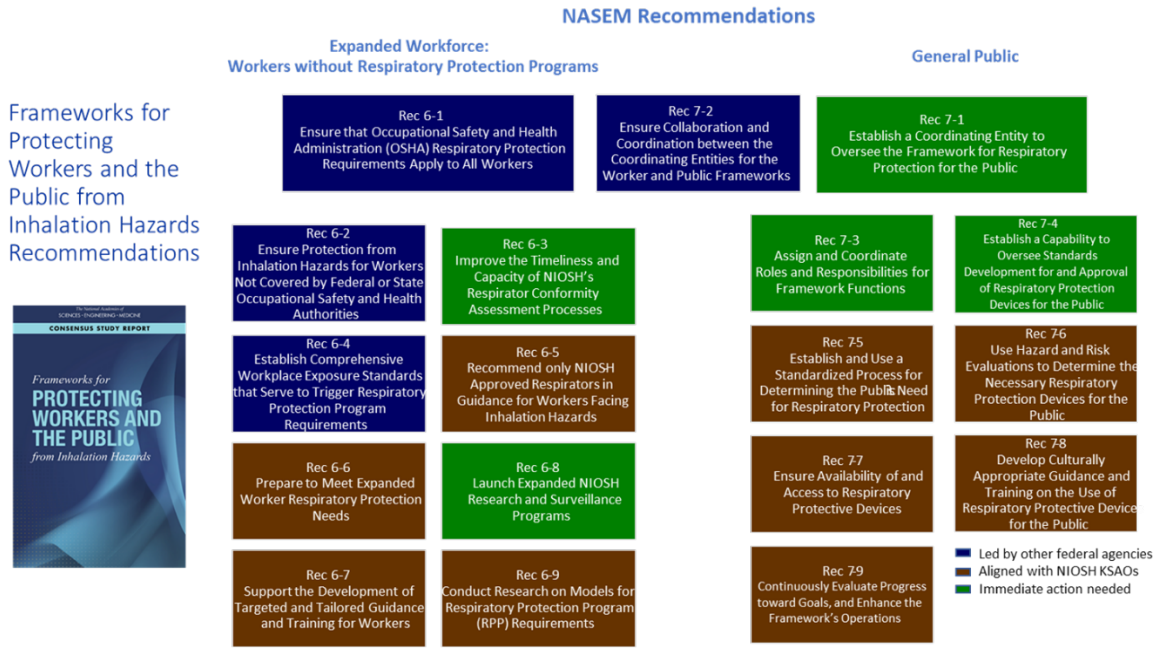

Figure 3. Recommendations from *Frameworks for Protecting Workers and the Public from Inhalation Hazards* categorized by agency alignment and urgency

This is a very comprehensive strategy requiring federal and private sector coordination at many levels, and the report was very clear that funding would be needed to execute these recommendations. Now what I'd like to do is share some closely related activities that are underway in parallel with this effort, and how they are linking together and aligning.

At a national level, after months of supply shortages, President Biden issued an executive order on January 21, 2021 which established goals to support a sustainable public health supply chain. As a response to this executive order, the US Government established a call to action by strengthening partnerships across the federal agencies and with the private sector. This move led to the development of the US National Strategy

for a Resilient Public Health Supply Chain report. And these emerging issues and national strategy efforts have increased the expectations on NPPTL substantially and have led to our involvement in national strategy in emerging issues that could impact our future operations.

The federal initiatives identified here are focused on addressing PPE issues that came out of the pandemic. The national strategy was published in July of 2021, and it was a White House initiative under the current administration that identified more than 30 plans of actions and milestones, or POAMs, to address supply chain issues. We were involved in the team that wrote that plan, and after it was published, we were asked if we could lead some of the POAMs and be involved in some others. We identified POAM 23 which is Product Standardization Task Force, and POAM 24, the PPE Innovation Center, as critical to our current mission, activities and efforts that fell in line with our expertise.

We have been leading these efforts since November 2021, and the Product Standardization POAM is focused on identifying the PPE standards gaps and addressing those gaps that could best move the needle, by identifying standards to address the gaps and product needs identified by gaps, and expedite the process to bring products to market. That's been a big gap, the bringing innovative products to market.

POAM 24 is the PPE Innovation Center, co-led by the Biomedical Advance Research and Development Authority (BARDA) and NPPTL, and it focuses on developing and operationalizing the vision for a PPE Innovation Center that will be housed in HHS's Public Supplies Innovation Center. And it will have a skeleton staff that is out of BARDA.

I put all of the NIOSH NPPTL activities underway and how they tie into these activities. They are in green. They all fall under the framework. It's everything that I described to you earlier, and they all are feeding into this Innovation Center and also the activities associated with that National Academies report where we are looking at what should that organizing entity be for the general public, and how will OSHA serve as that organizing entity for workers, and how will we bring this all together and work together with our federal partners to make this a smooth process.

This graphic is our vision regarding how federal, state and local governments, the private sector and academia will all act in a coordinated way. The areas in yellow are color-coded to show that these are things that are done by others, and those that are in white are areas where there should be NIOSH leadership, and then the faded white and yellow in the middle emphasizes our role in the coordination of these efforts. This Coordination Center, while it will have a skeleton staff, the vision is that all of these federal agencies you see here on the right in government, and then others outside of HHS, will be coordinating these priorities and helping to direct the funding associated with these activities.

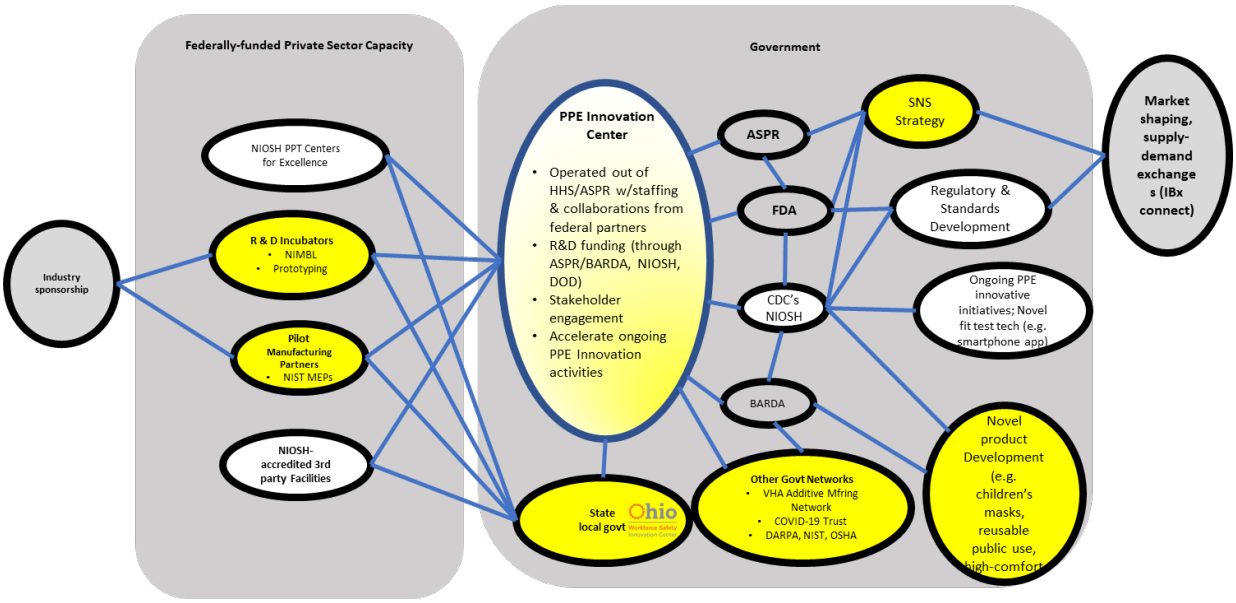

Figure 4. Federal Vision for the PPE Innovation Center Framework

This federally funded private sector capacity section on the left-hand side is completely new. It's something that has not existed for PPE in the past. It involves a number of agencies: NIOSH with the PPT Centers of Excellence and accredited, NIOSH-accredited third-party facilities, and BARDA with the research and development (R&D) incubators, and National Institute of Standards and Technology (NIST) with pilot manufacturing partners. And the vision here is that that the NIOSH PPT Centers of Excellence are going to be those organizations where that basic and intervention research is being done. That information is being fed into these R&D incubators and pilot manufacturing partners who develop those pilot programs and activities. Those prototypes that they have would go to the third-party facilities to validate that they are meeting requirements, prior to coming to NIOSH for approval. The hope is that this is a federally funded effort that would help bring products to market more quickly and help to spark innovation as well.

The timing of this effort is extremely important, as all of these things are aligned and there is some language with potential funding. In the Pandemic Preparedness Plan there is $1 billion for ASPR for public health supplies, innovation over five years, and $40 million for NIOSH NPPTL for improvements to the things that we are already working on. We look forward to continuing to see how these efforts evolve and how the partners continue to work together.

We've been thinking about how we position ourselves to remain the global leader in respiratory protection. Given appropriate resources and authority, we feel we can provide national leadership to address the framework recommendations of the National Academies report related to respiratory protection needs for workers and the general public. We will continue to work on the national efforts I mentioned, work with OSHA on workplace gaps as they are our longstanding partner in this space, and finalize a white paper on potential approaches to describe our involvement in these general public efforts. In the absence of authority—or until authority is created—we are working with our NIST partners to develop that framework to provide oversight for these efforts.

you have heard what our conventional activities are and how we are tied into the federal efforts underway. I have three questions for the BSC I'd like you to consider, and I hope you have some great input for me.

1. How can NIOSH remain the global leader in respiratory protection in its traditional areas of responsibilities given emerging issues and increased expectations resulting from COVID-19?
2. Given the increased number of workers whose respiratory protection needs are not being met, how can NIOSH best position itself to remain the global leader to address these needs?
3. How can NIOSH leverage its workplace expertise to best support the public's evolving respiratory protection needs as underscored by the COVID-19 pandemic?

Discussion

Dr. Su suggested that given the increased number of workers, we could make sure everyone who enters a room knows the level of cleanliness of the room so if there are additional challenges, they can put on additional masks. We could also have continuous indoor air quality monitoring in the workplace and rapid sensing to prevent infected people from entering the workplace, and then set criteria for not just what percent of particle sizes are removed, but what kinds of particles are removed. It would be sort of like how they rate buildings for environmental concerns. You could also have continuously updated rating for the indoor air quality. You would continuously certify your workplace according to the respiratory protection needs of the workers, and then make masks available as needed.

Dr. D'Alessandro: Yes, thank you for that suggestion. That's a great idea to put in to the innovation team.

Dr. Reponen: Yes, it goes to the assessing the hazard before giving the recommendation for respirators.

Dr. LeMasters: That was a wonderful presentation and I just want to commend you and NIOSH for all your efforts during this pandemic. My question sort of relates to number 1 and number 3, and that is related to the end user. And I was just wondering how the public, especially, could receive information about using N95s, for example, and understand that, you know, that these cloth respirator products that you can get everywhere are probably not going to fulfil the need for protecting you from COVID. And then with this judge's ruling two days ago that lifts the requirement to wear masks on airplanes, the public will not be using protective equipment, and what can NIOSH do to inform the public how to wear their PPEs? I seldom see the public wearing them correctly, or even using the correct PPE. How could you get that out nationally and worldwide to people in the public? It's a hard issue but I think it's a huge need out there.

Dr. D'Alessandro: Yes, thanks for that question. That is something that we do struggle with even throughout the pandemic. We were instrumental in providing input to the mask and respirator guidance, but there are a lot of levels of approval for that, and oftentimes, the more detailed information and descriptive information that we provided, others felt that maybe it would confuse people, and it was taken out, and taken out for other reasons that seemed to make sense at the time. I think revisiting a lot of the information that we did compile during the pandemic, and seeing how we can bring that back up, and even have that during conventional times I think would be useful. Thank you.

Dr. Demian: It's a question/comment/follow-up to the earlier conversation, but I guess we all realized that NIOSH has been involved in the respiratory protection in the traditional ways to the research, the testing, the certification process. And expecting or hoping that NIOSH alone could respond to all the other needs that the widespread use of respirators has created. All that structure, all that collaboration is probably going to meet the needs or fill the gaps in that respect. I remember that before COVID, this was kind of a world restricted to work. The respirators were primarily a personal protective equipment for work, and even there, we have had our education needs and awareness needs. And workers or employers or other groups who were not aware of what is a respirator, the fact that a mask is a respirator, an N95 is a respirator. The fit testing issues. I mean, there are these kind of a chronic, if you want, problems or issues that were difficult to be handled before the COVID. Now, COVID has sort of opened them up and expanded the standard, or the spectrum of users, if you will.

Question one, I was looking at how to remain the global leader in respiratory protection. I think I had an aha moment and I thought, you know, smart thinking, going to trademark and protect the process of certification, the labelling. And you showed something and I grabbed my respirator off my desk and I'm looking at it, and it says NIOSH, it says N95, it even says: For proper respiration use, wearer must be trained. Can we expand the message and say it what it is—fit testing? Because there's so much confusion out there about training, fit testing per se, the physical fit testing, how it's done, when it's done. A lot of gaps. This would be maybe just a way of kind of increasing the awareness even more, and just kind of keep NIOSH where it is, on top of all this work and research.

Dr. D'Alessandro: Thank you very much, yes, communications tools are very important and that's a big part of our strategy, but we have a lot of work to do there. Thank you.

Dr. Patel: First of all, thank you for so succinctly summarizing all those recommendations, otherwise it would have taken you days to just go through all of those in detail. A couple of points I would like to make. First of all, I'll try to piggyback on the idea of being a global leader, yes, great. And COVID-19 did expose some of the underlying issues in respiratory protection and how much people are aware about it. What I also observed is people may know, at least in the occupational safety and health world, about N95 fit testing requirements and so forth. However, when we were presented with challenges of global break in supply chain and increased demand, there was a lot of different emergency use authorizations coming out of FDA for a variety of different kinds of masks that were either produced in the United States but were not NIOSH N95-certified, or the ones that were in some ways meeting analogous standards of N95 and were imported from select countries. And this created a mass confusion right from industry level to state and local government level, and the general public. And from those experiences, I feel a good direction to move forward is if there was a way, while you were doing those tests, prepare a factsheet or a document. Right now, NIOSH has something that says oh, this is a cloth mask, this is an N95, and these are the differences. But if there are more ways of doing those comparisons and sharing it with general public, workers or industries, that would be very, very effective so this kind of confusion doesn't happen. Also, I see a lot of confusion happening, including in hospital sector where oh, is OSHA regulating it? Oh, is NIOSH telling us which mask to use or is FDA telling because it's a medical device for use in healthcare sector? I think that unified message needs to come out to

especially the healthcare industry so that kind of confusion doesn't happen when they go out to purchase some of these equipments for use for healthcare providers and in medical settings. That's number one.

Number two, what I also see is all these different other countries, they have their standards. How do they compare with NIOSH standards? There wasn't much literature available for us to refer, and I'm speaking this from personal experience serving on Texas Strike Force, tasked with trying to identify which PPE or mask am I supposed to approve, and I would like to applaud and commend you guys for creating that helpdesk because I don't know many times I've reached out to you guys and you all answered to me right away. So that being said, if there was a way to create like a guidance or like a document or a white paper just orienting people on what some of the major industry standards are for these PPE equipments that they need to comply for or look out to before they are going out and purchasing, that will also help you reduce a lot of these counterfeit and other issues that we have been confronting, or whether it's going to be the right PPE for that particular job or task, if it's coming not from the non-NIOSH N95 supplier or whatever.

And then last but not the least is I've also experienced, having worked for different state health departments over the years, when we start talking as a federal agency being the leader, yes, we all look up to you. But there needs to be boots on the ground. People at the local and state level, I can tell you, a lot of them don't even know what a fit testing means. They don't have anybody to do a fit testing. They will not be up to speed about different PPEs and standards and regulatory requirements and all of this. I feel that COVID-19 has presented us with this unique opportunity by exposing this gap, that a local and state level capacity building about PPE and its knowledge base has to happen, now more than ever.

Dr. D'Alessandro: Thank you. There are many good nuggets in your comments, a lot of things that we started, a lot of things we still need to do. One comment I would like to make is about the whole federal disconnect regarding the approvals. You're right, it's confusing because not only is the public confused about who has those responsibilities, but the government is confused as well because OSHA allows all NIOSH-approved respirators to be used in healthcare. They don't care what the FDA says. FDA says only surgical N95s can be used in healthcare unless there's an EUA. OSHA says the EUA wasn't necessary. The EUA was issued, and then people get confused because okay, why don't we have an EUA. We already have these things in our places.

There's a lot of work that needs to be done. We're working with OSHA and FDA on these. It's a slow process but just to get federal alignment to provide better guidance. Thanks for all your comments.

Dr. Pieretti: First of all, thank you for your presentation, and also I commend NIOSH for the efforts of trying to guide and educate people good in in the pandemic. And I'm going to piggyback with what everyone has said before.

One comment I would like to make, and you mentioned about the coordination with other agencies. As we all know, OSHA submitted—or presented—a temporary standard for healthcare when we talk about the mini respiratory protection program. It was kind of hard for safety professionals ourselves just to try to guide our clients about it. I think one, you know, if you can have that coordination and other members mentioned that, it's very important.

Also, when you talk about healthcare, I just had a quick comment. I suggest that you don't look at healthcare as hospitals. When you look into information about the healthcare, it's hospitals. But we have long-term care. And now, for example, in the past when there was an infectious disease before the pandemic, some of those long-term healthcare facilities, the procedure was to get them to the hospital. Well, guess what, that is no longer happening and it's not going to happen with COVID-19. So now, those facilities that were never exposed to the respiratory protection program, I believe now they have to start implementing those programs as well as ventilation requirements for negative pressure. My recommendation will be to, if possible, make the coordination with OSHA so there is a unified, or at least a more clear, message. And also within the healthcare industry, just not try to put everything to acute care but also don't forget about the long-term care that may need some protection from now on.

Mr. Morrison: The three questions that kind of blend together in some ways what actually took place. You did an enormous job during a period of time when we were out there working with—and just from my own industry in the fire service and the EMS sector—this was the biggest issue that we were faced with. Some of this stuff was supply and demand. I mean, it was price gouging, it was all those things that really prevented us from doing that. But one of the biggest things, and you did that I really have to compliment was trying to really get that message out there on the counterfeit respirators to the public, and there was a lot of questions out there, even in the fire service and EMS sections, there was a lot of questions.

I have two things. One, how do you stay on that? I think you continue to do what you're doing. I think what you've done well is that you have invited other stakeholders, and I think that's incredibly important. And I think you've heard it here too, the end user. It is so important to have that end user involved in the discussion because it's very easy to do something in an office setting but when you're actually out there with the workers, what are the workers saying? I think you've really reached out and that's, you know, our job, and I appreciate being partners with you on some of these projects.

I wish that we could maybe do more in the getting it out there, and how do we get it out there, simplify. We have to be careful about our message. It's very complicated, but you have to simplify it now to the end users. Are we communicating in ways that we could do short videos on, you know, doing it? That's what people want to see. That's what a lot of people want to know out there is how do I do it. Everybody here, I don't think there's anybody that's thought on this that hasn't gone to YouTube to fix whatever at their house. Simplifying it, making sure they understand it, maybe it is on the communication team. How do we get that message out? And people wanting to go back to the NIOSH website to use those. I wish we could put a QRS code on all the N95s so someone could just take a snapshot and, you know, what do they need to be aware of, of this product, you know, right away? And it's one that we're using more and more.

I'll end with the national stockpile. What do you know about the national stockpile as far as what are they going to be recommending for that stockpile? It seems like when you're in a lull, you have to be careful because we could get hit with another wave, and we're talking the same thing, that we should be preparing for. And in the national stockpile, are they changing what they are going to stockpile into the future?

Dr. D'Alessandro: Yes, so one of the most recent things that happened is that they made a decision to purchase 750,000 elastomeric respirators and they had done the first part of that, so about 325,000 I guess

have been purchased, or 375,000. They've purchased the first half of them about nine months ago, and we are working collaboratively with them. It's a grassroots effort. It's pretty neat the way that it's panning out. We put out a Federal Register Notice to solicit partners to partner with us to actually receive these respirators for free, and then we evaluate their respirators in the workplace.

These organizations will be transitioning from their typical filtering facepiece respirators (FFRs) and then we've looked at EMS organizations, so public safety and healthcare organizations. And then in the end, there will be reports written to show what had been the success of that, what were the mental health issues associated with it, what was the uptake, how did the workplaces like them? And then those reports would then feed into those overall best practice guidelines. So that's one thing, the 750,000 elastomerics. And about 100,000 or so have been distributed through this effort. The rest will be stockpiled and they're deciding what else they might do with them, whether it's some type of distributed stockpile rather than just staying in a warehouse.

And then they are looking at FFRs as well, and we've had some discussions about PAPRs, but those things are more under discussion right now.

Ms. DeGrasse: I echo a lot of the comments from the other participants, so I won't reiterate that. I will just add to the discussion, relative to educational materials, during COVID, we did partner with NIOSH in producing podcasts. And while we have the spectrum of folks in our membership age-wise and other, the availability of information is important. I think making it available in many different ways, via podcasts, via webinars, via the webpage X, especially, that could definitely transcend generations and make it available to the most amount of folks. I would just encourage that to be included, considered, going forward in how you distribute the educational materials. A lot of our members are in the driving profession, so podcasts work well for them, which is why we chose that method. They can listen to that in their earbuds as they're traveling down the road, and several other professions where they are allowed to wear headphones.

Also, with regard to the differing workgroups and the language barriers, having that information available in many different languages is certainly useful. We have developed factsheets over and over again as COVID recommendations changed, and having them translated into many different languages can be a challenge, especially with different dialects. However, it's still very so much needed within the communities who certainly can benefit from respiratory protection information and knowledge. A lot of focus was on healthcare, as it should have been during COVID. However, there are a number of other industrial sectors who also needed that level of protection, and having them understand how to use it, which one is the most protective, and delivering that training to them in a language they understand was a bit challenging. However, we were able to get it done, so that's something that NIOSH can do with their educational materials relative to respiratory protection. That would be greatly appreciated.

And then also, NIOSH is the research arm, and leading with science regardless of politics, regardless of public opinion, I think is most beneficial and establishing the highest level of protection is the highest level of protection. If it's not available to market, if it's an economic issue, that's someone else's wheelhouse to deal with. But leading with the best recommendation regardless of other contributing factors I think is important so that we can eliminate confusion —at the time, okay, it was oh, cloth-based masks are great. Oh, now

they're not great. Oh, now it's respirators. Okay, now we're back to respirators with exhalation valves, etc. So a lot of times, workers are super confused, and it kind of develops a mistrust that, oh, they change their mind every week about this, so we just do what we want to do. I think just from the jump, because we've got a lot of great research that's come out of this pandemic, just a lesson learned. Also lead with the science.

Dr. D'Alessandro: Yes, thank you for those comments. Yes, our motto is to bring the science to the standards, so that's what we strive to do through our work, and I completely agree with you that that's what we want to show. We want to show what are the best products out there, based on the science, based on the standards. Where are the gaps? And we need to be transparent and share that information. Thank you.

Dr. Reponen: For question one, how to remain a global leader is really lead with the science and innovation. I think NIOSH has done great job during the COVID-19 pandemic, very, very important research coming out—remarkable productivity. And answering those very practical questions on what kind of protection we get if only the person who is infected has, is wearing the respirator or mask; what about if the others are wearing?

Public Comment

Ms. Anca Bejan: Thank you. Hello, everyone, thank you for the opportunity to participate and speak in this meeting. I have a couple of comments related to the three questions posed by Dr. D'Alessandro at the end of her presentation. The first question was "What can NIOSH do better?" And I would like to speak to the need for more communication, especially when it comes to studies such as the ones mentioned with the Pittsburgh and University of Maryland facilities related to respirator use in healthcare. I think particularly targeted to healthcare workers, studies of successful implementation of reusable respirators are absolutely necessary. And I'm not asking for a peer-reviewed paper. I'm just asking for a clear, three- or four-page report: This is where we were. This is where we are. This is the messaging strategy that worked for us. And this is how you can implement this transition or change in your facility.

In regards to what NIOSH could do different perhaps in the future, I would like to speak to the need to continue the collaboration with OSHA offices, in particular with the OSHA Consultation, and strengthen the outreach possible through this collaboration. I think the current pandemic has offered a great example of how public health can rally and ensure that mass events can be organized safely, such as vaccination and testing. And I think we have a lot to learn—I'm a CIH myself—from how we can use these strategies to increase availability of critical services to workforce that, as one prior speaker said, was caught unaware of the need for a formal respirator program. I think through boots-on-the-ground work and a thoughtful intervention and education of people that can provide services such as medical evaluation for respirator use, respirator fit test, the training necessary, would be very helpful to bring more employers into compliance with the OSHA requirements and ensure that the workers are protected adequately.

If I may, I'd like to make one final comment and that relates to availability of respirators primarily to healthcare workers but to other workers on the front line, given that the government has such a very large stockpile that we are aware of and NIOSH, and NPPTL in particular, being involved currently in testing these respirators, I think it would be useful for the public to better understand why this resource has not been

accessed sooner in the pandemic, such as a year ago where the respirator manufacturers were gearing up their production capacity. That's all I have thank you very much.

Mr. Daniel Glucksman: Listening to the presentations in the beginning from Dr. Howard remind me that NIOSH really over-delivers. Sometimes I think it's like the best-kept secret in the government. And certainly Maryann's presentation about all that NPPTL has done in the past two, two-and-a-half years, also underscores that. I wanted to make a couple of comments on part of Maryann's presentation and then I don't know if Dr. Howard is still on, but another overall NIOSH comment. There was some discussion of the Centers of Excellence, and I'm with the International Safety Equipment Association [ISEA] whose members are companies that design, test, manufacture, and supply a wide range of personal protective equipment including respirators. And the Centers of Excellence, which was briefly mentioned in the middle of the presentation, I think could have tremendous value for everyone in the occupational and public health space. When we submitted amongst the leaders of ISEA ideas for Centers of Excellence, we really got back a wide range of research needs on every type of PPE that's out there. And I think the Centers of Excellence could deliver not only NIOSH's r2p, Research to Practice goals, but deliver results for end users, both the employers and employees, and manufacturers as well.

There's a range of pent-up demand for research that medium and small manufacturers can't do and perhaps even some large manufacturers can't do. But through a cooperative research hub like the Centers of Excellence, that kind of research could be done. And that also fleshes with some of the effort to find gaps in standards. I'd like to think that some of the research that could come out of the Centers of Excellence is research that manufacturers have identified are areas where standards could be developed. And I'm a little nervous that through finding the gaps in standards, we might—or I mean finding the gaps in standards is needed, but what we do with it afterwards. And that is if PPE is loaded up with standards that aren't being called for by employers and employees but then are mandated, it could have negative and perhaps unintended consequences in that either use could drop, people could seek less expensive and perhaps unregulated products. I know in the world of respirators OSHA requires NIOSH-certified respirators, but we've also talked about all these entities that don't fall under OSHA. So I think it's just caution moving forward in the whole gaps and standards effort.

And a final note—and this is why I was asking if Dr. Howard were on—we heard so much today about getting the word out and communicating getting the word out. And I would say to NIOSH or at large think about, as entities constantly go through reorganizations, beefing up the communications office—or even offices within the various labs—or finding a strategic communications consultant that could help get the word out. And whether it's designing more infographics, whether it's better connections to mainstream media, I guess the federal government can't use TikTok, but we've heard a lot about social media and exploring the range there. But it sounds like that's actually where there is a fair amount of need, in addition to funding the Centers of Excellence.

That's all. Thank you for the opportunity to make these comments in front of so many friends and colleagues, thanks.

National Center for Occupational Robotics Research

Intramural Research Presentation

Dr. Carr: I am Jacob Carr and I am the Team Leader for the Mining Technologies Team in NIOSH's Pittsburgh Mining Research Division here in Pittsburgh. And I do research on various technologies that may improve safety in the mining industry. But more importantly, for this talk today, I am also the Coordinator for the Center for Occupational Robotics Research, which is a cross-divisional virtual center within NIOSH for coordinating and conducting robotics research.

Today I'm going to talk to you some about our intramural work on robotics and then I will hand this off to Allen Robison, who will talk about some of the extramural efforts. As quick outline for my portion of the talk, I will first discuss some of the trends in occupational robotics and the implications for those trends in terms of worker safety and health. I'll then give a quick overview of who we are as a center and what we do, a few examples of our research intramurally. I'll discuss briefly some of the partnerships that we have that are so critical to our success. And then we've got some questions that I hope will inspire some discussion among the group.

To start off, I will talk about the trends that we see in occupational robots and what these trends mean for the safety and health of workers. We know that occupational robots, and in particular industrial robots, is a continuously growing field. We see for well beyond the last 10 years, but basically for the last 10 years, as you can see here from data from the International Federation of Robotics (IFR), the number of units in operation has steadily grown over the last several years for industrial robots.

We can also look at the number of installations of robots annually. This is essentially the rate of growth of units in operation. And we can see that that also has grown from 2015 to 2018, and then slacking a little bit in 2019 and 2020. But the IFR is projecting that that growth will continue and I don’t see any reason why it wouldn't continue to expand and see more and more robots in the workplace at an increasing rate.

I'm going to make a distinction here between traditional robots and emerging robotic technologies throughout the presentation. When I refer to traditional robots I'm talking about the types of robots that we've been using in manufacturing and other settings since the 1970s and 1980s. These are robots that are fixed in place or they are kept behind cages and guards to isolate them from the human workers. There's a dedicated space for the robots to work in that is separate from the space that the humans work in. And these robots are widely used for welding, painting, and many other manufacturing tasks and other tasks.

And there is a very good safety record with these robots. We looked at a number of fatalities from the Census of Fatal Occupational Injuries (CFOI) data from 1992 through 2015 and what those researchers did is they used keywords to look for accidents that were related to robots or robotic technologies. They identified 61 fatalities that were related to robots. Of course any number of fatalities is tragic, but to put it in perspective, it does account for less than 1% of the more 190,000 workplace deaths during that time. I think we can safely say that the fact that these robots are behind guards, in cages, or fixed in place where they're isolated from

the workers, definitely has a lot to do with that and contributes to that strong safety record with these machines.

However, we are seeing more and more that these traditional applications of robotics, although they're still definitely the dominant form of robotics in the workplace, they aren't the only applications that are being done. We see more and more collaborative robots, like the example shown here, where you have a robot and a human working in a shared space on a shared task with a common goal that they're both working on together. This of course opens up a lot of possibilities in the types of work that can be done and the capabilities of the human workers that can be enhanced with robots. However, it also creates the potential for some increased risk.

We do see that collaborative robots are still a fairly small portion of the market. This is a chart of the sales of traditional versus collaborative robots over 2017 to 2020, with the traditional robots in green and collaborative in purple. You can see that it is still a small portion of total sales; however, it's a growing portion of those sales with 11,000 units sold in 2017 compared to 22,000 units in 2020.

Another trend to take the collaborative concept to another level is exoskeletons and exosuits. These are robotic technologies that are worn actually by a worker. They are powered devices that can be worn on the upper body or lower body or both, to enhance worker capabilities and reduce risks for musculoskeletal injuries. However, given the fact that these are mechanical devices that are in direct contact with the human body, there's obviously some concerns there and potential for the creation of some new hazards.

Another trend is the use of robots more and more in spaces that are shared not just with workers, but with the population at large. We have drones that are being used for workplace inspections at construction sites, agricultural sites, mining, many other places where drones are being flown and used autonomously and under remote control. We have autonomous equipment in places like agriculture, mining, and construction, where you may have a piece of equipment that is being controlled by a computer and working in an area where there are other human workers or other pieces of equipment being controlled by humans. And then finally autonomous vehicles, I think everybody is aware of the growth in that sector where you have vehicles on the road driving alongside human-operated cars and that creates, again, possibilities but also the potential for new things we need to keep in mind.

One more trend I will talk about is service robots. And service robots really some interesting things happened over the last couple years with these applications. If we look at the top five applications of service robots, those are transportation and logistics, professional cleaning, medical robots, hospitality, and agriculture. It's interesting to see the areas where those sales have really jumped up in transportation and logistics, professional cleaning—nearly double in professional cleaning—and then more than doubled the sales from 2019 to 2020 in medical robotics. And that clearly has to do with the pandemic for those three areas. That is an interesting trend in the adoption of robotics for some different applications and uses.

And then the final kind I'll talk about is artificial intelligence (AI). We know that robots are increasingly using AI and machine learning. That definitely increases the capability of those robots; however, it also creates the possibility that we don't always know exactly what is going on inside that machine learning or AI algorithm. AI

can be somewhat of a black box to the workers nearby and it may not always be clear what the robot will do or why depending on how that AI framework is designs and built. That is another trend that we keep an eye on.

I'm going to shift now and talk some about a couple of case studies involving robots in the workplace to highlight some of the impacts that robots may have on the safety and health of workers. The first case study is from the Fatality Assessment and Control Evaluation (FACE) Program through Washington State, in partnership with NIOSH. This case study was a fatal injury involving the robotic forklift shown. And what happened is, you can see the plastic material on the person's hand on the top right, it became entangled around the forks and obscured a sensor that you can just see at the bottom of the robot. And as the worker went under the forks and cleared that plastic, the sensor became unobstructed as he pulled the plastic away and the robot, once it saw that the sensor was unobstructed, it continued moving and lowered the forks down onto the worker resulting in fatal injuries.

Another case study involves demolition robots. These are remote-controlled machines, which somewhat stretches the definition of robot, but these machines are used in the construction industry to demolish buildings. They're a tracked machine with a hydraulic arm with a breaker hammer at the end of it. And they're controlled with the remote on the right side. We've got two examples highlighted in this FACE report of workers who were injured when they were caught between the machine and the building that was being demolished. They were pinched between a part of the machine and a part of the building, resulting in serious injuries. And this highlights some of the risks that can happen when you have workers and robots in the same shared space and not isolated behind guards or in dedicated robot work areas versus human work areas.

We look at all of these trends at both the potential to reduce harm, as well as concerns for the creation of potential new hazards. And I've tried to highlight some of those with each of these trends as I've talked about them. But it is an important aspect of what we do that we look at both sides of this coin. On the one hand there's a potential to reduce exposure to hazards, there's the potential to augment human capabilities, for example, with the human exosuits. But there are also concerns for increased interaction between humans and robots, like we just saw with the demolition robot. There's the concern that rapid advances in the technology may outpace standards and regulations. It's no surprise that technology does tend to move a little bit faster than the regulatory process and a little bit faster than the standard-setting process.

And then finally the psychosocial impacts of the change in workplace. There's stress associated with displacement of workers, downward pressure on wages and different factors like that, as well as just changes in how the work gets done and the identity of who has ownership of that work. There are some definite human factors/issues there that need to be kept in mind throughout the process

Just to give a few examples of this sort of two-sided coin of potential to reduce exposure, as well as potential to introduce hazards. We have traditional robots, we can reduce exposures to welding gases and other hazards associated with welding; however, there may be new hazards introduced with the maintenance of those machines. With mobile robots, those could be used potentially, and have been used, for search and rescue operations, just as an example. But there's also the potential for unintended contact with workers or, if you're doing search and rescue in an environment like an underground coal mine where you have methane

or other explosive atmospheres, you may run the risk of igniting those gases with the electrical equipment on the robot. And I won't go through in detail with the others, but with things like exoskeletons, drones, collaborative robots, all of these technologies offer the potential to reduce exposure of workers to hazards, but they also can create unintended consequences. And really both of those are the focus of what we do with our research.

That brings us to the Center for Occupational Robotics Research. We are a virtual center within NIOSH and we were established in September of 2017, so still a fairly young center. We are a virtual center, which means we don't have a brick-and-mortar location. By myself, I'm in Pittsburgh. Our manager Dawn Castillo is located in Morgantown, and then we've got researchers really from throughout the Institute and across the country with a very wide range of expertise in engineering, epidemiology, human factors, and just a very diverse group of individuals. And this center is encompassed within the NIOSH Future of Work Initiative, which was launched in 2019. Our mission is to provide scientific leadership to guide the development and use of occupational robots that enhance worker safety, health, and wellbeing; and as I said, to look at that more in terms of potential, as well as potential unintended consequences.

We've got some world-class laboratories that we are still building. We're in our fifth year as a center and there is still some potential to build on our laboratories. One of the labs I'll highlight is for anthropometrics. When we think about interactions between humans and workers and collaborative robots or, in a more direct sense, with exoskeletons and exosuits where the workers are wearing the robots, it's important to understand the anthropometry of the workers.

We have virtual reality facilities where we can do tests in a simulated environment to introduce hazards to workers in a safe way. Workers can interact with things in the workplace and we can see the effects of different workplace scenarios involving robots on human behaviors without actually introducing those workers to physical hazards.

The robotics laboratory in Morgantown has a number of stationary and mobile robots that we can use to investigate different scenarios with using those robots in different ways. And finally is the experimental mine at the Pittsburgh campus and it's an actual underground coal mine that has been used for the mining research obviously, but also offers an environment for testing robotics. The picture shown there is actually from the Defense Advanced Research Projects Agency (DARPA) Subterranean Challenge, which was a competition that DARPA put on to bring teams into autonomously explore that underground mine using robots.

The scope of our research does include traditional robots; however, that's a minor focus compared to our focus on emerging technologies. And I've talked about really all of these, but collaborative robots, coexisting and mobile robots, wearable robots and exoskeletons, remotely-controlled and autonomous vehicles and drones, and the robots that use AI to an increasing degree.

With that I'll jump into a few examples of our intramural research and then after this Allen is going to talk about some of the extramural research. The focus areas for our research do include basic and etiologic research, intervention research, research translation, and surveillance, so we've got focus areas that touch

on all of those types of research. The first is to identify opportunities to better protect workers' safety and health using robotics, so how can we use robots as an intervention to improve safety. The second is increasing our understanding of human-robot interactions to ensure human work safety so we know that as we have more and more collaborative robots, we're going to have more and more human worker-and-robot interactions and that creates the potential for those hazards. We want to improve the ability to identify and track injuries, so surveillance. And surveillance is a challenge with robotics because a lot of the surveillance tools that we have really weren't built necessarily with these emerging technologies in mind. It's another example of the technology sort of outpacing our structures that we had in place logistically. And then finally, providing guidance on working safely with robots in the workplace.

I'm just going to go quickly through a few examples of our intramural research. The first is a project on drones in construction and their effects on workers at heights. This research is somewhat behind schedule due to the pandemic. We've had to push back human subject testing due to limitations on access to the lab for our researchers as well as for human subjects to come in and do the test. But the idea here is to investigate the effects that a drone, an unmanned aerial vehicle, may have on a worker at a construction site working at an elevated position. If you've got that drone flying around, is there potential to create distraction and could that distraction lead to a loss of balance or some other potential injury. The second example project I'll highlight is on demolition robots. We've got a project investigating the hazards associated with those robots and trying to really understand how those injuries occur, why those injuries occur, and whether there are strategies for mitigating those. And then the final one I'll highlight here is a project using the Ohio Workers' Compensation program looking at data from 63 case studies through that program of industrial robot applications and other programmable manufacturing automation, to investigate how those injuries happen and how those surveillance tools may be used more effectively.

I'm going to shift focus now to partnerships. And partnerships, of course, are critical to our success and I think it's been a real strength of the Center over our first five years of existence that we've built some really strong partnerships and some really productive partnerships. They are critically important for helping us to ensure our relevance, ensuring that we target our research to the needs of the stakeholders and of the workers. It establishes collaborative research opportunities with universities and others working in these fields, as well as with companies and field site potentials where we may do research. And then, of course, it builds pathways to put our research into practice, so critical to our success.

The first one I'll talk about here is our alliance with OSHA and A3, which is formerly the Robotics Institute, RIA, but now A3, the Association for Enhancing Automation. This alliance was signed in 2017 and it has been a very productive alliance. Recently OSHA published and updated an expanded chapter in the OSHA Technical Manual. The chapter is on Industrial Robot Systems and Industrial Robot System Safety. And that chapter of the manual will provide some improved guidance on the use of robots in the workplace and the ways in which workers can be kept safe with robots in the workplace. And that really, in large part, came out of this alliance between OSHA, A3, and NIOSH.

A second partnership that has been very important to our success is with ARM, which is the Advanced Robotics for Manufacturing Institute. That is a government-private consortium of researchers largely funded

through the DoD. Their headquarters here in Pittsburgh is a former steel-working facility that's been converted into high-tech research facilities for ARM and for others. ARM funds projects aimed at the technology readiness level 6 to 7 range, the technologies that are coming into maturity and on the verge of being manufacturable and being able to be put out into the workplace. NIOSH has attended their meetings annually and we have contributed to many of the discussions and built partnerships out of this Institute.

The third major partnership that I'll highlight is with the National Safety Foundation (NSF). And Allen Robison is going to talk more about this in his presentation. But the NSF has the National Robotics Initiative, or NRI, which we've participated in for the last few years. And listed here are a couple of projects that we have funded through that NSF call for proposals, the first on lower-limb wearable robotics, and then the second on a transparent and intuitive teleoperation interfaces for nursing robots; so certainly relevant today with that one.

And then, of course, we've got several other partnerships that I don't have time to highlight with groups like National Information and Technology Research and Development, National Safety Council in their Work to Zero Campaign, North Carolina State University, Wisconsin-Madison University, and University of Florida, NIST, Jet Propulsion Laboratory, and others.

We're also very much involved in standards development and standards committees. There are a few standards from the American National Standards Institute (ANSI) and International Standards Organization (ISO) on robots that are out now for industrial robots, industrial mobile robots in an ISO 299 on robotics; there's also standards under development from ASTM for exoskeletons and exosuits; and then standards that are in the predevelopment stage related to unmanned aerial systems and partial- and fully-automated vehicles. And we have representation and involvement with all of these standards groups.

If you'd like more information, I would encourage you to visit our website, which is CDC.gov/NIOSH/topics/robotics or, if that's a mouthful, then you can just Google "NIOSH robotics" and it's usually pretty easy to find. And what I would suggest if you go to our website is to scroll down to the bottom and you'll see some links there on About Our Center: Research, which goes into more detail on the different projects intramurally and extramurally that we've got that I was able to show here today; Partnerships and Resources, talking more about these partnerships I've touched on; and then many of our Publications, journal papers, conference papers, blog posts, and different useful resources on that Publications page.

Extramural Research Presentation

Dr. Robison: The Center for Occupational Robotics Research was engaged with the National Science Foundation before NIOSH undertook to participate in those funding opportunity announcement that NSF publishes. Jacob's slides provide a preview of one of the topics that I'll talk about.

I'm going to talk about three main areas of NIOSH extramural research. I'll talk about the National Robotics Initiatives, the National Construction Center small studies, and then a compilation of other extramural research that touches on robotics.

There are six strong partners in the National Robotics Initiative. You'll recognize most of the logos. I don't know that I need to explain any of them. And NSF has built a pretty strong collaborative partnership among the six and NIH is the most recent group to join this effort.

The National Robotics Initiative partnership is valuable for several reasons. It advances the NIOSH research portfolio in occupational robotics research. It really does leverage resources with federal partners; we'll look at an example of that. And it raises NIOSH research needs among established robotics, the established robotics research communities, really.

NRI 2.0, when NIOSH started participating in these funding announcements, it was about ubiquitous collaborative robots. Here are the themes and the project classes and the NIOSH priorities. It was published in December of 2019. There was a very short receipt window, from February 12 to 26. That was not a lot of time for folks to apply, yet we had a really good response to this.

The robotics research, the occupational safety and health research that was funded is shown here. NIOSH is investing about $1.6 million over three years. NSF over three years is investing about $2.3 million. When we talk about leveraging funds, this truly is an example of that. We invest and they invest, and they can invest more than we can so we're happy about that.

This is a part of the poster that this grantee provided as an update, and this is about transparent and intuitive teleoperation interfaces for future nursing robots. And I want to just talk about a few things. One, the robot here, which appears to be sitting on this tray, but it is not actually doing that. This robot is mobile and sort of reminds me of Robby the Robot from the old science-fiction movie Forbidden Planet, which may be too far back for some of you to remember. But the operator can virtually operate the robot. The robot can also be autonomous in terms of mobility. There are some feedback loops between the user and the robot, blending of controls for sensitivity, and tactile feedback and response. And the soft robotic glove that's illustrated includes tactile muscles, tactile sensors, inertial movement units, and also electromyography sensors that can detect muscle activity, muscle fatigue, and muscle effort.

This is a similar graphic from the second project which is about, as you can see, customizable lower-limb wearable robots. The key focus of this graphic is about the soft, wearable sensors that are incorporated here at various parts of the body to measure certain things, like heart rhythm or increased pressure in the ankle/foot interface area. It's really an intriguing project and I would encourage you to look at a human-inspired robotics lab for the first project and then the second project is being performed by Rehabilitation Robotics Laboratory at the University of Illinois at Chicago.

Here are some notes about progress for these grants that were funded in 2020. These were funded late in the year. First-year reports are generally not indicative of the actual productivity that is going on. We'll have second-year reports in August, and we'll have a better idea of what folks have actually accomplished.

Let me talk just a little bit about the NRI 3.0 innovations and integration of robotics. And the research needs that NIOSH identified are listed here. Integration of robotics for reducing workplace exposures, physical risk and sociotechnical challenges of robotics technologies. And you can see some of that going on with the nursing assistant project and then different risk control strategies. That announcement was published in

2021. It had two multiyear receipt dates for 2021 and for 2022. And I'll talk a little bit about the outcome of that next.

NSF has funded one occupational safety and health research project from the FY21 competition. NIOSH, because these applications were received very late—and they went through peer review and secondary review—but because of the lateness of the receipt date, those processes were not completed prior to CDC deadlines for obligating funds. We stopped at the point of having some recommendations that went to Dr. Howard and approved, and we couldn't make any funding decisions because there was no funding that late in the year. As Dr. Howard mentioned this morning, we've only recently received our FY22 budget and so we'll be looking at this as one of the extramural activities to fund and to see if we'll be able to do that. There are a lot of competing priorities this year, and as always.

For 2022 there were 180 applications received; 26 of those were related to occupational safety and health, 9 of those were responsive to NIOSH requirements. They'll be peer-reviewed in mid-May, and then we'll move forward from there to see what we might do. And beyond 2022, NSF is retiring the National Robotics Initiative. They've already started the replacement program, Foundations Research in Robotics, and they've been accepting full proposals on a continuous basis since August of 2020. And as they accept those applications they will periodically look at the number that have come in on a monthly basis and then probably on a bimonthly or possibly quarterly basis, they'll schedule peer reviews to deal with those applications in a more or less real-time basis.

I want to switch to talk about the National Construction Center small studies projects[1]. It's also a collaboration between CPWR-Center for Construction Research and Training and NIOSH. And it's a collaboration because NIOSH scientists are engaged with providing feedback on the announcement itself and then looking at what the National Construction Center proposes to fund after they've completed their competitive process. And all of these are about drones except the middle one, which is about human-robot interaction safety risk. Whether it's called an unmanned aerial system, a drone, or an unmanned aerial vehicle, there's a lot of activity in that area. And Jacob talked about drone research related to construction as well. This gives you an idea of how we engage with one extramural partner.

We have a variety of extramural applications that have been funded in the past, recent past, are still ongoing, and continue out into the future, for another year or two in a couple of cases. And so I just will walk through them by the type of activity that it is. And the first two are conference grants, which of course pull together a variety of researchers who are working on any number of topics, but also robotics and robot research topics. And then the Centers for Agricultural Safety and Health conference, there's the quote, "Robotic innovation is most successful in strawberry and apple tree fruit harvest." And so that's not an atypical finding. It doesn't only happen in Washington or in the Western United States.

Then there is a group of three Education and Research Centers (ERCs) listed here, and they are doing a variety of research, and have done some research since 2013, on robots and robotics. And the University of

[1] Note: CPWR-Center for Construction Research and Training is currently funded as the National Construction Center

Utah is one of those with a pilot project and a subproject as part of their targeted research training on human safety interactions and then ergonomics related to human-robot collaborations. And then two other ERCs, University of California, Los Angeles (UCLA) and University of North Carolina, have done some work related to robotics. And UCLA had a workshop and North Carolina is conducting the two pilot projects: one on the analysis of OSHA severe-injury reports and then factors affecting trust in high-vulnerability, human-robot interactions. The western miner project is a miner-training grant for training miners in the Western U.S. It's actually training workers. And most people would recognize that mining, that's an area where there's a high level of interest and use in robotics. And then I'll just jump to the last two which are two current mining research projects—one in Missouri, one in New Mexico—about underground escape technologies and human factors. And those, of course, do involve a bit of robot research and robotics.

To summarize, the extramural robotics research portfolio is broad in nature. It covers a variety of industry sectors and it involves some specific centers: Ag Centers, ERCs, and the National Construction Center. It includes a variety of different types of research projects, from pilot research projects to investigator-initiated research and conferences and scientific meetings. It builds on strong collaborations with the National Science Foundation and the National Construction Center, and really collaborations between individual NIOSH researchers and individual extramural scientists. And those represent multiple paths to support occupational robotics research and it's an area that's continuing to grow and emerge.

I would acknowledge these people, several who have been mentioned: Dr. Sharon Chiou works in the Office of Extramural Promise. You know Jacob. And Dawn has been mentioned, and Frank Hearl, who is the Chief of Staff for NIOSH. Thank you.

Discussion

Dr. Carr posed two questions for the Board to consider:

1. What trends exist with new robotics technologies that NIOSH research should aim to address?
2. What aspects of robotics in the workplace would it be useful to have health and safety guidance for?

Dr. Reponen: Thank you, Dr. Carr and Dr. Robison. This is an emerging topic, and as we have learned there are various types of robots, collaborative robots and so on, and also the use of artificial intelligence is increasing. And obviously there are challenges of how to make them safe at workplace. Here we have here the questions from the speakers and so now the podium is open for comments and questions and hopefully also some comments for these specific questions.

Dr. Su: I think it'd be great to develop robots such that when workers check in, they can evaluate their physical and mental state so you could see how stressed someone is or how well-rested they are; have robots sort of automatically be able to check people in, vaccinate people, perform recordkeeping. And I think we'd want to make them foolproof, easy to operate.

And in terms of what aspects of robotics in the workplace, it would be useful to have health and safety guidance for noise levels; smell, in case they're emitting anything harmful; light, in terms of if there are large amounts of light; and some kind of failure prediction mechanism.

Dr. Carr: It's an interesting thought with using robots as a check-in on wellness and mental state. We think a lot about the sort of negative impacts of robots on human-worker wellness and stress, fears of displacement and things like that. Yes, that's a great comment that we could use those robots as well to try to have some positive impact on the wellness of workers.

Dr. Barton: Yes, I just want to compliment you all on this presentation, a lot of interesting ideas were brought forth that I was not really that much aware of, especially with the collaborative-types of robots. And I know I'm supposed to be answering a question but, really, I'm kind of focused on something that you brought up in the first presentation, which is the rapid advances in these robots is outpacing standards and regulations. And so my real question is how can you address the somewhat of a lag between the standards and regulations with all of this technology and new advances? I'm not really sure how to answer that question and I was wondering if you might elaborate a little more.

Dr. Carr: I think that is sort of the million-dollar question and major challenge of, given not just growth in the technology but the fundamental changes in how we interact with robots and what robots are capable of. If you look at, for example, artificial intelligence, if you were to ask researchers from 15 or 20 years ago the capabilities that might be possible with artificial intelligence in the future, I don't think that they would have been able to give you an accurate picture of what we are now capable of with the technology. Trying to anticipate where the technology is going and what it's going to be capable of and how those new capabilities may create the potential for unintended consequences and the potential for things that we would need regulatory oversight on or standards on, is a major challenge. I don't know if I have a good answer, but I would just acknowledge that that is the million-dollar question.

Ms. DeGrasse: Thank you for this presentation. I do want to make a few comments, ones relative to the previous comment that we definitely know that it's a situation going on relative to the automated vehicle space where this technology is not only emerging, it's already here. It's already deployed in revenue-producing runs, etc. And a lot of times the folks in the states just operate on a premise, well, there isn't a reg that says I can't do it. Until there is, they're going to go ahead and do it.

Keeping in the vein of the automated vehicle space - of course no one wants to stifle innovation. We want to remain competitive. But within our occupational safety and health realm, we want to make sure that this technology is deployed in a useful way, taking into consideration the human operator and the human interface and how those interact. Because one person said, yes, we are humans and things go wrong, but a lot of times there are things that go wrong even with the robots. They are programmed by humans and there has been bias that has been programmed into some of the automated technologies that just doesn't take into consideration different aspects like, for instance, facial recognition was based on anthropometrics of a white male. It didn't work well for darker-skinned females. Knowing that, having a set of rules in place or a guidance document to make sure that things are considered when engineering these technologies, that biases are considered, thought of, and planned for to try and engineer that out.

And then just relative to automated vehicle space, I know a lot of the technology works with radial frequency waves, which generally are not harmful but I just can't help but think of the cumulative effects within this entire connected environment that we are moving toward where there is technology embedded into every

single infrastructure that's being built. Into roads, into stop signs, into red lights in the sidewalks, also in vehicles, and how this combined use of radio wave technology—or any other type of technology like that—is there a combined effect on the body if someone is operating vehicles every day—8, 12, 14 hours a day—with operators still in the vehicles, is there a combined effect of all of these technologies on the body that may be coming at them from the car next to them, the street under them, etc. And I've always just wondered about that and if there's any research relative to that space.

And then also the sensors; we talk about the robotics and the inertial measurement units (IMUs). There are a number of tech companies who are developing IMUs, and they are piloting them in warehousing especially. And I just also wonder if there's an acceptable level of practice that could be developed with implementation of these sensors. I had read some work by NIOSH, probably Emanuele Cauda, and he talks about Right Sensors Used Right. And so just to understand or have a guidance for stakeholders who represent members in these industries, like when an employer wants to deploy some of this, what is the pathway that should be taken, the best practice that should be taken when deploying, or even piloting, some of these new devices that humans may have to wear wearables or work alongside or with these devices.

There is like a gold standard—or there was a gold standard—for this IMU device which had many different sensors, but there are some companies now that are developing with a limited amount of standards or sensors as far as measuring ergonomic postures, etc. And so just want to know if there's also, I guess, a tool that can evaluate the different products that will come to market that says, oh, we can get the same job done with three sensors—because it's more cost-effective, obviously—than just product that has 12 sensors to monitor for bending, twisting, lifting, etc. But how do we know? Is there a standard that should be used when evaluating these different products on the use-case limitation? So you have a product that's claiming to say, oh, we can give you all of these anthropometric measurements with only three sensors placed on different parts of the body, but that's not really giving you a true picture of the load on a human body in this warehousing space when lifting heavy objects, especially 70 pounds or more, which is a typical within the right-on-time delivery system.

Dr. Reponen: Thank you, Enjoli. That was a lot of good ideas. I didn't see any projects that were focused on these automated vehicles, but maybe I missed it. Is there anything going on in NIOSH or extramurally?

Dr. Carr: We do have the Center for Motor Vehicle Safety which works with the Center for Occupational Robotics Research and has some of the same researchers involved. We don't have a project right now that is looking at autonomous vehicles. But that is definitely a focus area. And I will say that in the comments that Enjoli had, I definitely appreciate as well. The one that you highlighted with the anthropometrics and the, for example, training of AI algorithms was mostly white faces and things like that, that definitely highlights some of the unintended consequences that can happen with AI that if we don't take into consideration and through no mal intent, we can still have inequitable outcomes and potentially dangerous outcomes. So that's an important thing to look into.

Ms. DeGrasse: And to piggyback off of that, we talk about that within a design of PPE, how there isn't PPE that was specifically designed for a woman's stature. And the same could be said for wearable devices and taking in consideration equity and design.

Dr. Pieretti: First of all, thank you for the presentation. This is a question and a comment. The first question is, is there a priority in terms of research with robotics? For example, I would think that when you have robots with high human interaction such as exoskeletons will represent a higher risk of injury, versus the autonomous robots or the autonomous vehicles. Is there such a thing within NIOSH?

Dr. Carr: Yes, I would say all of our research in the proposal stage we evaluate in terms of burden, need and impact. We look at burden in terms of the number of injuries that exist or the exposure that exists in the workplace with the technology that we're looking at and how we can address it. But, yes, it's a good point that when you have increased interaction with humans, or even wearing the robot on your person, that creates an increased potential for injury and an increased potential for exposure. But this also speaks to the surveillance question and the challenge that we face with the lack of good surveillance tools and specifically at those types of scenarios. This is a new technology that's continuously evolving and people come up with new things and then we don't have the historical data for those new things. And that is sort of the framework we look at it under.

Dr. Pieretti: Thank you. And that builds up to my next question or comment, and obviously as NIOSH and us in safety, we are playing sometimes catchup because we have to try to fix or try to assess the equipment or processes after the fact. I think what I'm trying to say is that maybe it would be a good idea to come up with a collaboration to create a framework for safety and health of robots. I think someone mentioned, and one of the slides mentioned the sensor that was being covered with a string and therefore, once they took it out, it activated. Well, when you think about it, perhaps a good lockout/tagout or machine guarding program or approach would have prevented that.

I wonder, are you aware of any kind of a framework that is out there where people or companies—at least within the United States—that are working with robots can come up with a way the key elements should be addressed when developing this type of product? NIOSH could create this kind of a framework for all of the manufacturers in the United State to make reference to. And I think that would alleviate somehow the catchup process that was going on. And it's going to happen just because NIOSH is only one; there are hundreds of product manufacturers.

Dr. Carr: Absolutely, yes, and I appreciate that comment. I'll just speak for myself, but I look at two aspects of what you bring up. One is the system safety approach in terms of the technology in looking at it as an integrated system of technology, a human, and a workplace all together, what interactions take place? What can go wrong? If something does go wrong, what would the outcomes be? So, in a scenario like the forklift where the worker got down and cleared the plastic that was tangled and uncovered the sensor, that was a scenario that clearly wasn't thought enough about in the design and perhaps couldn't have been anticipated.

But the other part of it that is probably the harder nut to crack is the human beings. We are all humans and sometimes we do things that are unpredictable and don't make a whole lot of sense. And studying that part of it is where things like virtual reality facilities come into play. And I highlighted the project that we had on drones in construction and spoke about it fairly quickly, but the thought there is if you have this drone that's buzzing around your head and potentially distracting you, what does that do to the human behavior? What does that do to our focus on our work and our focus on hazards in the workplace, things like that? Or if

you're working with mobile robots that are zipping past in a warehouse setting, things like that, how does that affect our behavior in the workplace? And that's a tough question to answer and it plays into that system of a human worker and environment.

Dr. Reponen: We discussed on the importance of having some kind of guidance for those who design and who manufacture and also make sure that they pay attention to the health and safety. But then also at the workplace, are there any protocols on what can be done at workplace to do like a safety check or kind of training? How do you need to train the workers? What aspects to pay attention to with this kind of robots to avoid this like fatalities and injuries.

Dr. Carr: Yes, training and workplace practices and procedures definitely is an area where guidance may be needed.

Ms. Castillo: First of all, thanks so much for the great comments and suggestions and the questions. I did want to speak to a couple of the questions that were raised that had to do with the technology outpacing the standards and how to address that, and then the issue that was raised about the guidance for the manufacturers and the workers.

It's a real challenge that the technology's advancing so quickly, but that's part of the reason that we're engaged with these standards committees is because while we may not have all of the science, at least we're bringing the occupational safety and health perspective. Those standards are addressing the manufacturer and what types of safety is programmed into the computer or the robot. And there's also standards that are going to be developed in terms of how you implement it, the things that you look at. It's a tough nut, but in our mind, participating on the standards committee provides us an opportunity, while we may not have the science, we do have a lot of experience in occupational safety and health and we bring that to bear.

And then the other thing that participation on the standards committees does is it also helps us identify research needs so we can see what questions are coming up in the standards committees, the scientific challenges, and we can incorporate that into the research agenda. Thanks again for all the great comments and questions so far.

Dr. Reponen: I want to ask about the extramural collaboration with NSF. It sounded like NIOSH doesn't have a separate block of money. If they are highly rated grant applications coming, are they going to be in line with all the other extramural grants? How is that treated in the extramural program?

Dr. Robison: Remember Dr. Howard this morning talked about earmarks and he talked about discretionary money? The research that NIOSH has funded in robotics to this point extramurally has come out of our discretionary funds because that's the only source of funding that we currently have. If we had an earmark for robotics that would be nice, I think, but we currently do not. And that's quite common.

Dr. Reponen: Still about the extramural research - you mentioned that the National Construction Center has a collaboration with NIOSH. How about the other projects, do they have interaction/collaboration with the NIOSH robotics center?

Dr. Robison: I think to varying degrees they do, but some of them may not. And we would encourage that, of course, that they do that. And sometimes one of the things that we've talked about doing to help strengthen that is to have webinars from the ERC folks or the Ag Centers and have them do webinars and to help make the connection between the work that they're doing and the interest in the work that the Center for Occupational Robotics Research is doing.

Dr. Reponen: Yes, I think that that would be a good idea. Any further comments on these two questions? Are there any trends that have not been brought up yet that our NIOSH research should aim to address? How about guidance? We mentioned already some guidance things which are already going on with the standards development. I think it was an interesting comment that also this positive use of the robotics on how to assess workers' health and exposure that the robots could be used for that one too.

Ms. DeGrasse: One comment was brought up earlier about the psychological stress and having even that built into a robotic check-in. Although I'm not sure if we'd get good results just because a lot of workers, in my experience, have an aversion to robots so they're always going to say, "To heck with this robot." But we have conducted some preliminary research on psychological stress of automation, which did show that stress levels were higher, especially related to employee surveillance and how automated technologies and wearables could be used to surveil employees and under the guise of health and safety, but also incorporating these productivity measures within the device and how that could lead to disciplinary action.

I think that guidance also can come with caution as to why or what the benefit is of a technology. What's the use-case scenario? Like what is your issue, really, so that we can know what the technology does; which specific technology would function in the way that you would intend it to that's needed? For instance, in the trucking sector, the Federal Motor Carrier Safety Administration (FMCSA) mandated that trucks had to have electronic logging devices. And they set up basic minimum standards for these devices. Not to say that an employer couldn't Cadillac it up, for lack of a better explanation, but there are minimal criteria.

I think that could also be useful with some of these technologies, especially the wearables, for the test that is designed to be to measure body temperature in outdoor workers, or indoor workers, for instance. Like what is the minimum criteria that should be met to accomplish this goal so that you have workers and other stakeholders, worker representatives and others can understand what this technology does, what's the minimum operational criteria, and then know that anything beyond that could be considered beyond the scope of this device. It gives us some information as to, okay, this is required for this use, but this is not necessarily required. We can be informed and question why certain things were included in this particular model and what is their basis.

A model could be My Car Does What. People buy these cars and have no idea how to operate the new technology. There was a website developed called My Car Does What that kind of had videos and education materials to help civilians understand what their car does. So that could also be useful within this realm of robotics and automation and what it does. How can it be useful to the employee? And because that will also limit the misunderstanding that employees have always that they're being monitored and watched.

When I put dosimeters on some employees, they completely think it's a recording device and that Big Brother's there. So having other videos that come from an organization like NIOSH to say, “Okay, this is what this does, this is the intended purpose," could be useful in helping to calm some of those fears.

Dr. Carr: Yes, that’s a great comment. And I'm going to have to check out that My Car Does What because we bought a new car back in October and it does some things that I don’t understand quite what it's doing. But, yes, your comments about the resistance to the new technologies by workers and the concerns about privacy, the concerns about loss of locus of control to some extent, that’s sort of in line with some of the past research that I've been involved with, not on robotics but in the mining realm with introduction of new safety technologies.

We had a project on collision avoidance and proximity detection systems that detected when someone's near a machine and preventing their contact, and then also dust exposure using a camera and a dust meter to evaluate when workers are being exposed during the workday. And we did interviews, not in my group but in the Human Factors Branch here in Pittsburgh to really look at that and look at what are those concerns of the workers. And we found some of the similar things I think that you're highlighting and it cuts across all introduction of new technology and it's sort of a perennial problem we keep running back into.

Ms. DeGrasse: And one final point, someone did bring up noise. There are a number of automated facilities in the warehousing industry and they are very noisy. We have not yet done an official noise study of a warehouse, but there are a number of complaints and so that’s actually an unintended consequence.

Dr. Carr: Yes, definitely, and then going back to the comment you had before about RF exposure and potential effects of that. These are problems that we know exist, noise and exposure to RF radiation and things like that, but we need to maybe revisit those.

Summary and Wrap-Up, Future Agenda Items, Meeting Dates, Closing Remarks

Dr. Reponen: To summarize, we had two very interesting topics and lively discussion and hopefully there were useful comments to the presenters and to NIOSH. I think we've identified at least one potential future agenda item, which was communication. And communication came up actually in several instances so I think that might be a very, very good time to bring in. There is also at NIOSH an Extramural Communications group that has been very active. I think they meet monthly. And of course there are other communication initiatives around NIOSH. Any other potential topics anybody else has in mind?

Dr. Pieretti: I believe this has probably touched in the past, but with the Great Recession we had employers scrambling to get workers in. And they have several interesting articles about how to engage retired people going back to work. So perhaps will be nice to touch again on the aging workforce and, more specifically, now that some employers are scrambling to get employees, they may be getting part-time, retired people. So now we don’t have full time, just part-time, older workers and how that would affect their productivity and, most

important, the injury rates because these are people that, again, just part-timers. I think it would be a good idea just to recap all the workforce and especially this emerging area.

Dr. Graham: I was wondering if it would be possible to discuss the evolution of the NIOSH Hazardous Drug List [referring to the NIOSH List of Antineoplastic and Other Hazardous Drugs in Healthcare Settings] through the years and where it's at now and where it seemed to be going.

Dr. Reponen: I think we already have two standing topics for the fall. We have the evaluation capacity plan that we have to score. We get an update on that and that needs to be scored. And then we have firefighter registry update. The subgroup committee has been working and meeting so they're going to give us an update on that work. I don't know how many additional topics we can have.

Ms. Novicki: Yes, probably just one additional topic, but it is possible for us to give updates in a written form. So that's also something that we can touch on without a full presentation.

Ms. DeGrasse: For additional topics, there is a large, unregulated workforce in the small-package delivery sector. They operate vehicles that are less than 10,001 pounds so they don't fall under FMCSA regulation. And they are operating in interstate commerce. They don't necessarily fall within OSHA jurisdiction when they're on the road. I think that that's an area that needs some exploration as to what this population of workers is experiencing as far as occupational safety and health is concerned. And if there needs to be some coordination between regularly agencies on where this group falls and how they can be protected on the job.

Mr. Foley endorsed Ms. DeGrasse's recommendation.

Dr. Reponen: We have meeting dates here next, but usually we do it later.

Ms. Novicki: Yes, so our next meeting will be in October, probably early October. It will definitely be virtual so we'll be doing it on Zoom again. And Pauline Benjamin, our Committee Management Specialist, will be reaching out probably in the summer about potential dates.

Dr. Pieretti: Do you foresee for these meetings to be virtual from now on, or is this team planning to meet personally, live?

Ms. Novicki: Yes, that's a great question. We used to meet in person twice a year in the spring and fall. Since the Zoom meetings were working so well, we decided to go down to one in person per year and one virtual. And the in-person would be in the spring and obviously we weren't ready to have that in person this time. The fall meeting really needs to be virtual because of the way our fiscal year works and our ability to pay stipends and reimburse travel. So that's why we decided to do the spring one in person and then the fall one virtually in early October. We're still figuring out how all of this is going to work, whether we're going to do hybrid meetings going forward or what. Everyone's comfort level with traveling and being in gatherings is different right now and we're trying to be really cognizant of that. People have different medical histories and situations. We're still kind of playing it by ear right now. But I can't say with certainty that the meeting will be on Zoom in the fall and then we'll keep you posted about next spring.

Dr. Reponen: To conclude, I want to thank Emily very much for keeping us on track. And thank you for all of the board members, and thank you for presenters, and thanks for the very lively discussion. And I will see you all in the fall.

[Adjourn.]

Glossary

Term	Definition
A3	Association for Enhancing Automation
AI	Artificial Intelligence
ARM	Advanced Robotics for Manufacturing Institute
ASPR	Office of the Assistant Secretary for Preparedness and Response
BARDA	Biomedical Advance Research and Development Authority
BSC	Board of Scientific Counselors
CBRN	Chemical, Biological, Radiological and Nuclear
CCER	Closed-Circuit Escape Respirator
CDC	United States Centers for Disease Control and Prevention
CFOI	Census of Fatal Occupational Injuries
CoE	Center of Excellence
DARPA	Defense Advanced Research Projects Agency
DFSE	Division of Field Studies and Engineering
DSI	Division of Science Integration
EHMR	Elastomeric Half-Mask Respirator
EMS	Emergency Medical Services
EPA	Environmental Protection Agency
ERC	Education and Research Center
FACE	Fatality Assessment and Control Evaluation
FEMA	Federal Emergency Management Agency
FFR	Filtering Facepiece Respirator
FMCSA	Federal Motor Carrier Safety Administration
HELD	Health Effects Laboratory Division
HHS	U.S. Department of Health and Human Services
IMU	Inertial Measurement Units
IFR	International Federation of Robotics
ISEA	International Safety Equipment Association
NIH	National Institutes of Health
NIOSH	National Institute for Occupational Safety and Health
NIST	National Institute of Standards and Technology
NPPTL	National Personal Protective Technology Laboratory
NRI	National Robotics Initiative
NSF	National Safety Foundation
POAMS	Plans of Actions and Milestones
OMB	Office of Management and Budget
OSHA	Occupational Safety and Health Administration
PAPR	Powered Air Purifying Respirator
PPE	Personal Protective Equipment
PPT	Personal Protective Technology
R&D	Research and Development
RF	Radiofrequency
RPD	Respiratory Protection Device
RPP	Respiratory Protection Program

Certification Statement

I hereby certify that, to the best of my knowledge and ability, the foregoing minutes of the April 20, 2022, meeting of the NIOSH Board of Scientific Counselors, CDC are accurate and complete.

Tiina Reponen

Digitally signed by Tiina Reponen
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Tiina Reponen, PhD

Chair, NIOSH Board of Scientific Counselors