

Video Exposure Monitoring: A Real-Time Monitoring Tool



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A black and white photograph of a chain-link fence. A heavy metal chain is wrapped around a vertical post of the fence, with a large padlock attached. A white rectangular sign is pinned to the fence with the word "CLOSED" written in large, bold, black capital letters. The background shows a blurred view of a building with windows.

CLOSED





A microphone on a stand is positioned in the upper left corner, casting a bright, conical spotlight across the dark background. The spotlight illuminates the text 'VEM' in a bold, black, sans-serif font, which is centered within the beam of light. The background is entirely black, making the white light and the text stand out prominently.

VEM

**EMPLOYEE
OF THE
MONTH**

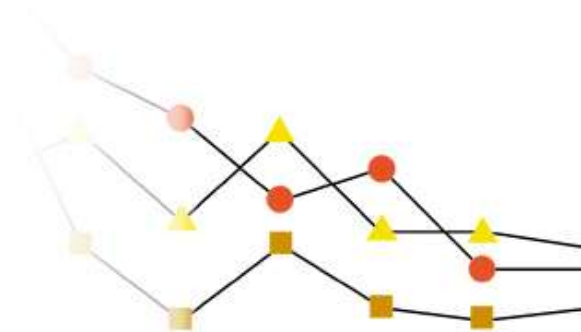


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Introduction

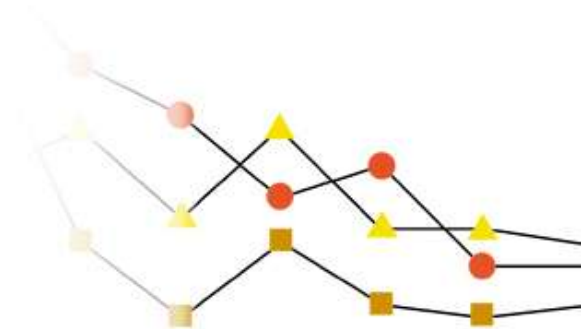
- Occupational hygiene tool since mid-1980s.
- Low-cost video cameras available in the market.
- Real-time monitoring already in use.
 - Lacked data logging capabilities.
 - Reasons for peaks were hard to explain.
- The National Institute for Working Life (NIWL) in Sweden.
 - Discussed possibilities of linking video with real-time monitoring instruments for exposure measurements.
 - First practical trials were done in a woodworking shop measuring organic solvent exposure in spray painters (Rosén and Lundström, 1985; Rosén and Lundström, 1987)
 - Second version displayed exposure data with a bar graph.
 - PIMEX (Picture Mix Exposure)





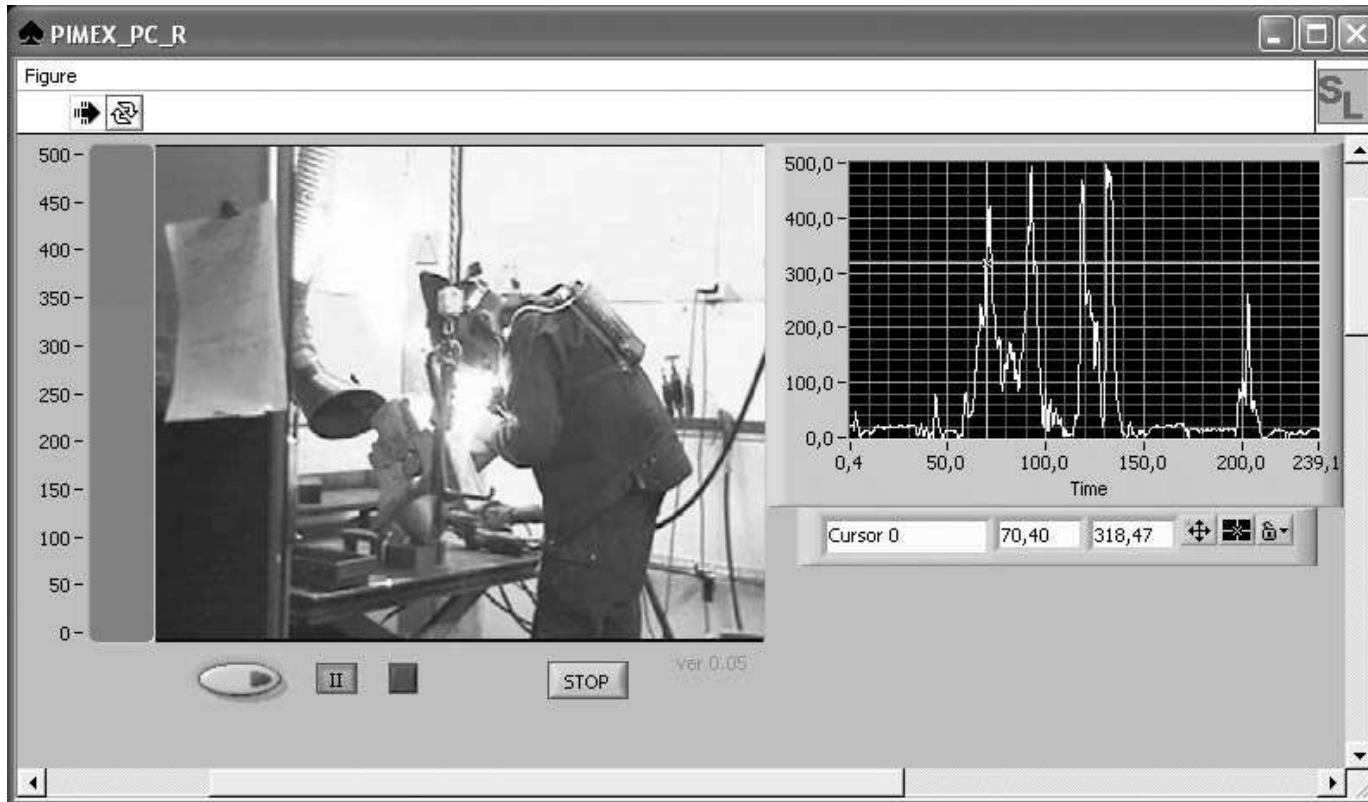
Introduction

- At about the same time NIOSH researchers (Gressel *et al.* 1987, 1988) also described using a similar technique.
 - First tests used light scattering instrument
 - Measured dust exposure during manual weighing of acrylic copolymer powder and during cast cleaning in a foundry.
- The experience was similar to those of the Swedish group.
 - Advantage of being able to show graphically to management and workers how the workers' activities and practices can affect their exposure



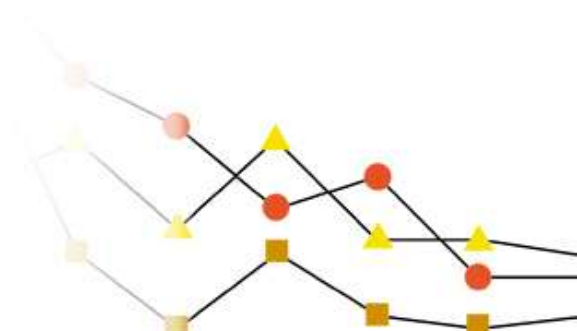
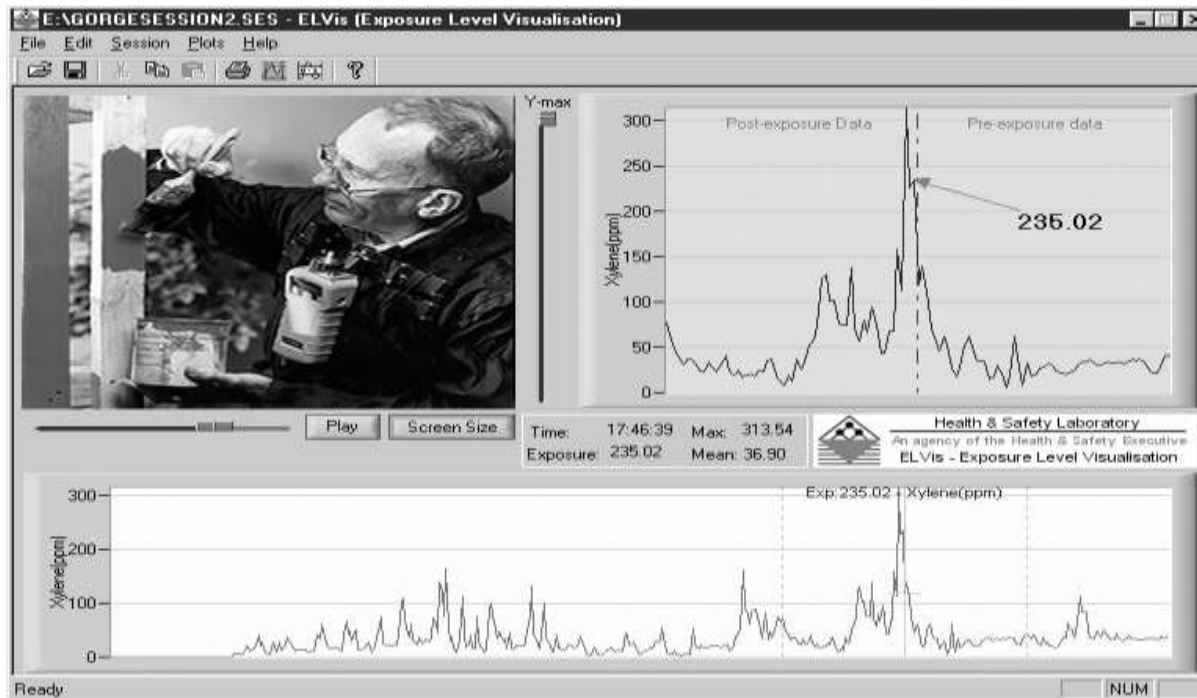
Introduction – Other Systems

- PIMEX-PC (NIWL, Sweden)
 - 2 versions of specially developed software:
 - For data collection, showing picture and data on computer screen in real-time and stored on hard disk.
 - To replay video and data.
 - Both versions can present digital data with line or bar graphs.



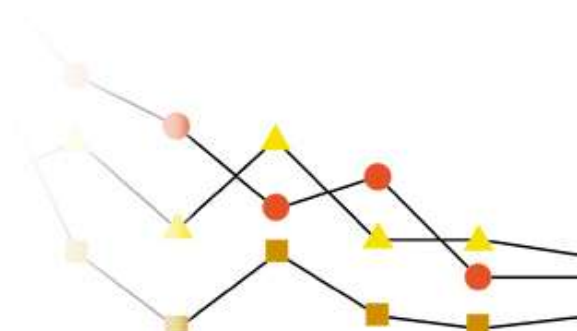
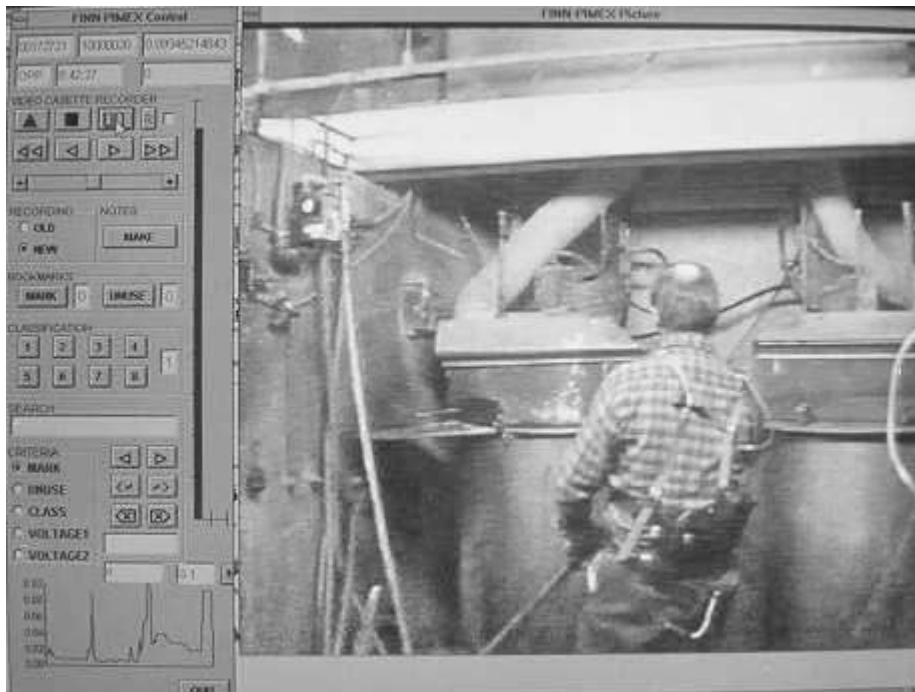
Introduction – Other Systems

- Exposure Level Visualization – ELVIs (HSL, UK)
 - Digitalized video and exposure data can be mixed and displayed on a computer.
 - Data can be averaged over any period.
 - Data can be labelled in a hierarchical, Gantt chart style.
 - Automatically calculates peak exposure concentration, % of total time and % of total exposure on a particular task.



Introduction – Other Systems

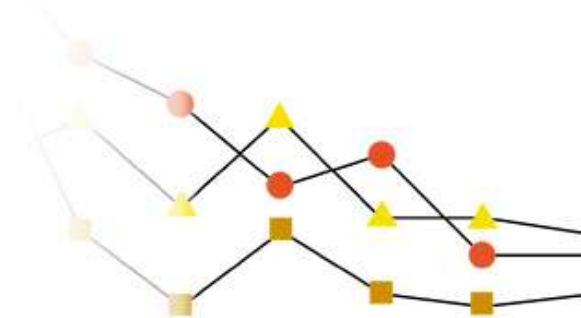
- FINN-PIMEX (VTT, Finland)
 - Developed during 1996-1999
 - Video stored with a tape recorder while measurement signal stored in a database.
 - Post-capture analysis – can classify working tasks and use marking tags.
 - Make fast searches of the data using different criteria (e.g. signal level, user classification, marking tags).





Introduction – Other Systems

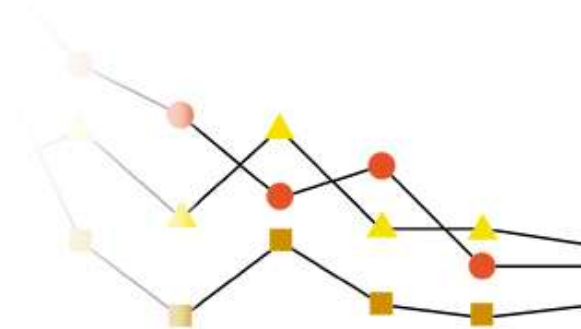
- **CAPTIV (INRS, France)**
 - Developed in 1999
 - Consisted of two main modules:
 - Data acquisition – information from sensors presented in the form of a time series and the video window is active.
 - A characteristic feature is this ability to adjust the time offset caused by the finite response time of the detector.
 - Workplace analysis – specific periods, such as interesting work tasks, can be searched and viewed.
 - A number of signal processing tools are available to assist data analysis, e.g. the ability to identify a peak or a group of peaks higher than the specified value of the background threshold.
- **KOHS PIMEX (KOHS, Austria)**
 - Commercially available system.
 - Can handle several different video sources.
 - Video and data compressed in real-time on the main system.
 - Immediate playback capability.
 - Multi-channel input system, e.g. can measure three different sized dust particles and heart rate simultaneously.





Introduction – Other Systems

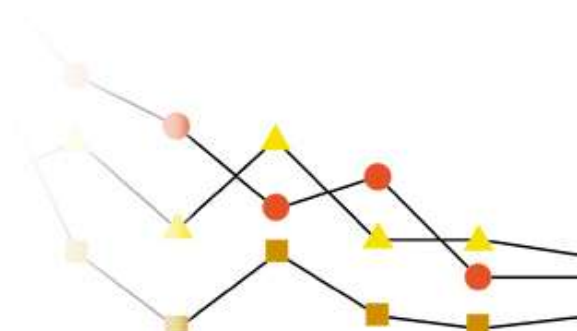
- **GRIFFITH PIMEX (Griffith University, Australia)**
 - (Bromwich, 1995)
 - Original system recorded noise data stored on the audio track of a camcorder which was then overlaid onto the video on a computer.
 - Current system integrates data acquisition, logging and digital FM telemetry on a single circuit board.
 - Up to six channels.
 - Video data from a webcam can be compressed onto a laptop computer.



Introduction – Other Systems

- VEM (USA)

- NIOSH (Kovein, 1997) and Purdue University (Xu and McGlothlin, 2003) researchers have further developed the earlier work of NIOSH's VEM system.
- Purdue University's system has evolved to use completely wireless video and environmental sensors that can be captured, analysed and sent anywhere in the world through secure internet systems.
 - Still ongoing developments.
 - Multi-channel input capability.
 - Bookmarking and tagging functions.
 - Immediate playback.

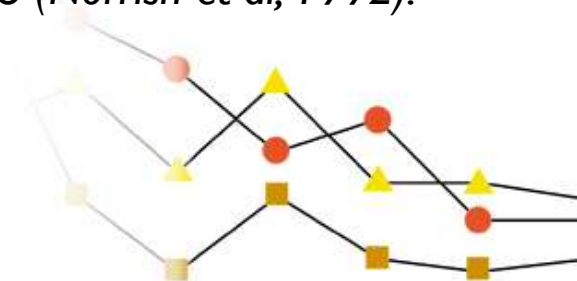


Video Exposure Monitoring
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Background

- Wood dust is a carcinogen (*IARC, 1995*).
- Exposure to wood dust (especially hardwood dust) has been shown to be linked with nasal and sino-nasal cancer, (*Demers et al, 1995*).
- Exposure to wood dust also associated with increased risk of lung cancer (*Barcenas et al, 2005; Jayaprakash et al, 2008*).
- Wood dust exposure is associated with non-malignant respiratory effects, e.g. shortness of breath, wheeze, dyspnoea, rhinitis, asthma (*Talini et al, 1998; Rongo et al, 2002; Arbak et al, 2004*).
- With exposure to wood dust known to be associated with health effects, and the wood processing industry to be relatively large (~17,000 carpenters or joiners and ~3,500 cabinet makers or furniture makers), more studies in New Zealand are required.
- Only New Zealand study was conducted nearly 20 years ago (*Norrish et al, 1992*).



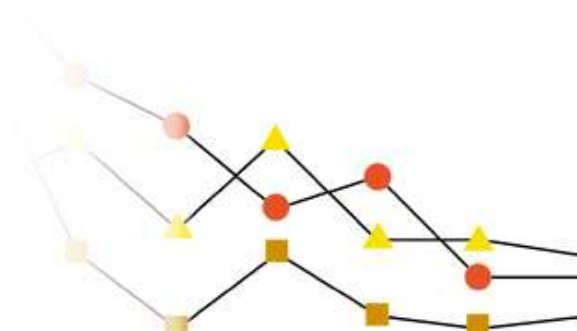


Exposure Survey

- Back in 2008, an exposure survey of inhalable dust, respirable dust, and formaldehyde levels in joineries and furniture making shops (in Wellington, Auckland, and Hastings) was conducted.

	Inhalable dust	Respirable dust	Formaldehyde
Joineries	2.48 mg/m ³	0.27 mg/m ³	0.014 ppm
Furniture Makers	1.22 mg/m ³	0.12 mg/m ³	0.012 ppm
All workers	1.82 mg/m ³	0.18 mg/m ³	0.013 ppm

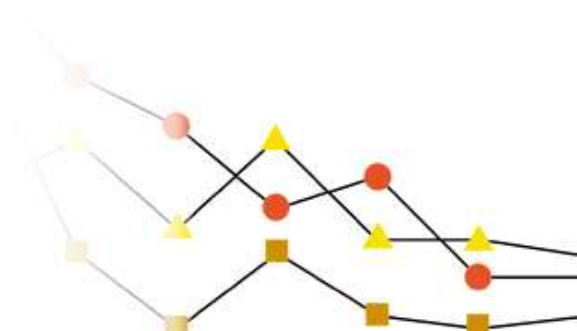
- At the time, the workplace exposure standard was 5 mg/m³ for softwood dust.
- From Dec 2010, the workplace exposure standard was lowered to 2 mg/m³.
- Our next study – an intervention study – builds on this.





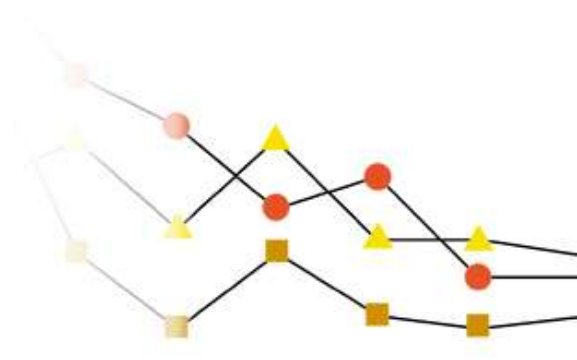
Workplace Interventions to Reduce Wood Dust Exposures in Joinery and Furniture Workers

- Previous study used 8-hour TWA
- Did not give facts about the nature of the hazard.
- Peak exposures can attribute >70% of TWA exposure (*Meijster, 2008*).
- Real-time video exposure monitoring will visualize workers' hazard exposure through second-by-second video capture.
- Better understanding of the hazard through visualization techniques.
- Leads to increasing workers' knowledge of risks associated with certain tasks, and how they can be controlled, which can improve health.



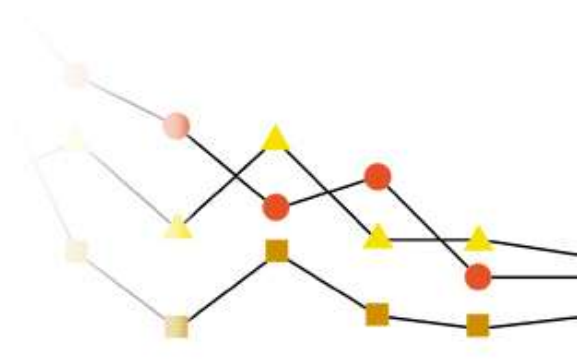


Aims

- To conduct a comprehensive literature review on workplace interventions intended to reduce airborne exposures.
 - To conduct exposure measurements in joinery and furniture factories to *identify* peak inhalable dust exposures during specific work tasks using real time exposure monitoring.
 - To conduct experiments in joinery and furniture factories to *evaluate* the efficacy of particular interventions on peak inhalable dust exposures.
 - To conduct an occupational hygiene assessment to assess control measures currently in place and their efficacy.
 - To develop, implement and evaluate a full intervention strategy for joinery and furniture factories based on the results of above.
- 



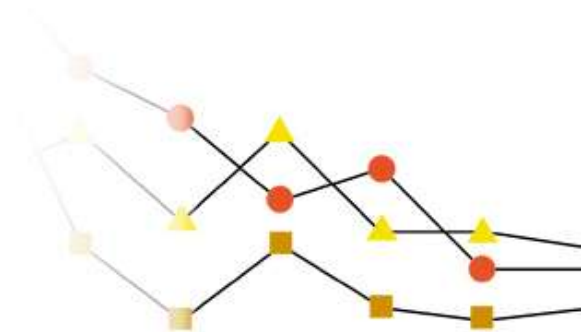
Methods

- 8 workplaces from the previous study were recruited for this intervention study.
 - 8-hour TWA exposure levels were measured monthly for a 6 month period.
 - During this time, occupation hygiene surveys were conducted.
 - During this time, video exposure monitoring was conducted to measure workers' activities and peak exposures in 50 (25) joiners and (25) furniture makers.
 - The subjects have previously participated in our exposure survey and are representative of the industry as a whole.
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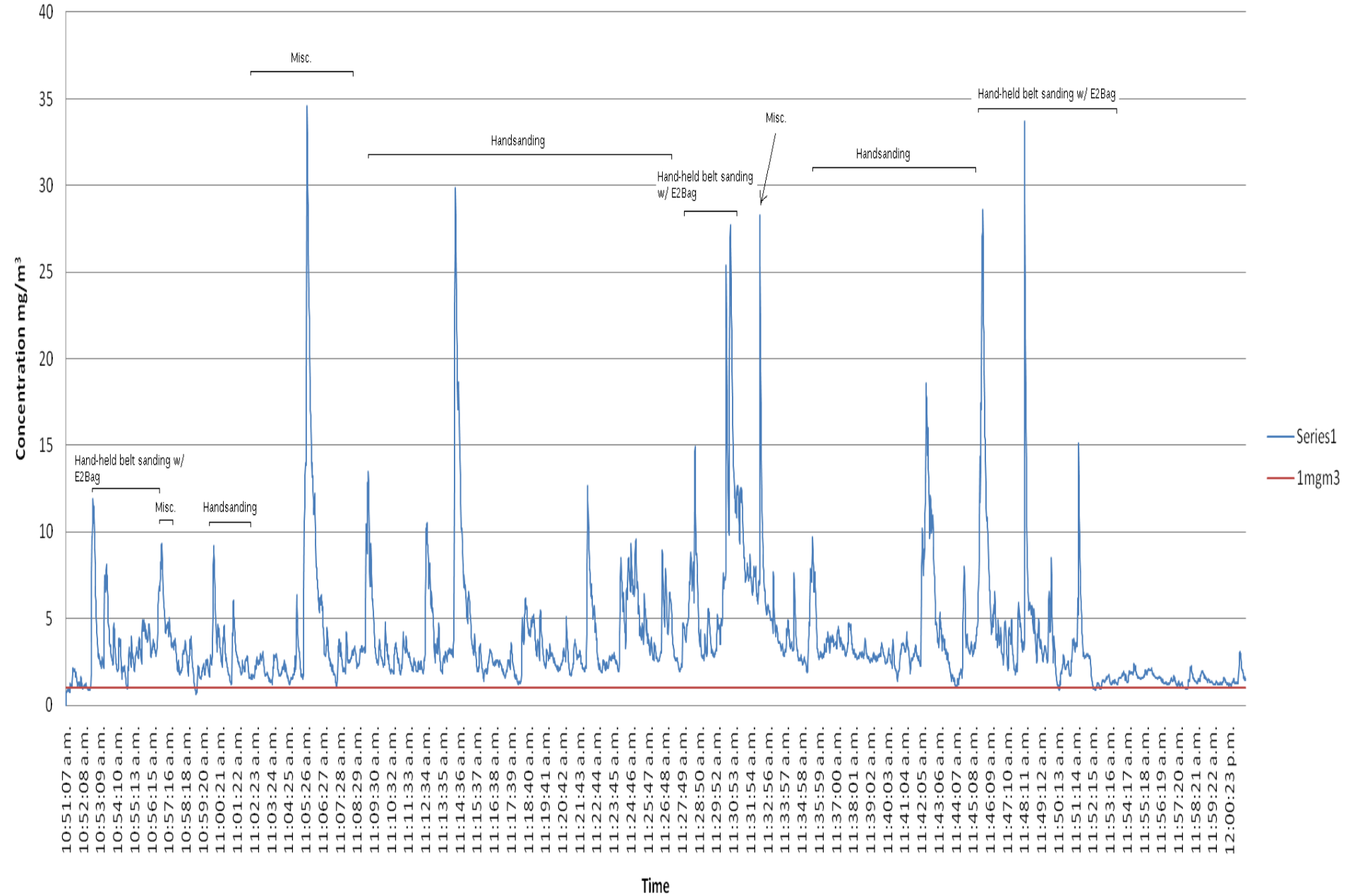


Main Outcomes

- A comprehensive literature review.
- New insights into determinants of peak dust exposures and the effectiveness of control measures in this industry.
- An overall intervention strategy aimed to reduce peak exposures.
- To be able to use this intervention strategy and apply it to other small-scale NZ industries with high dust exposures.



Wood dust exposure over time



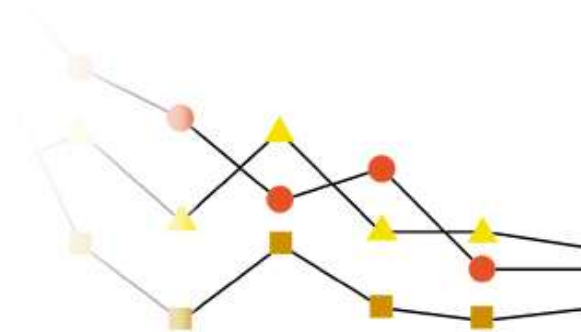
A person is using a stick vacuum cleaner on a construction site floor. The vacuum is silver and black, with a wide, flat head. The person's legs and feet in dark boots are visible in the background. The floor is a light-colored, dusty surface.

stofzuigen
op de
bouwplaats



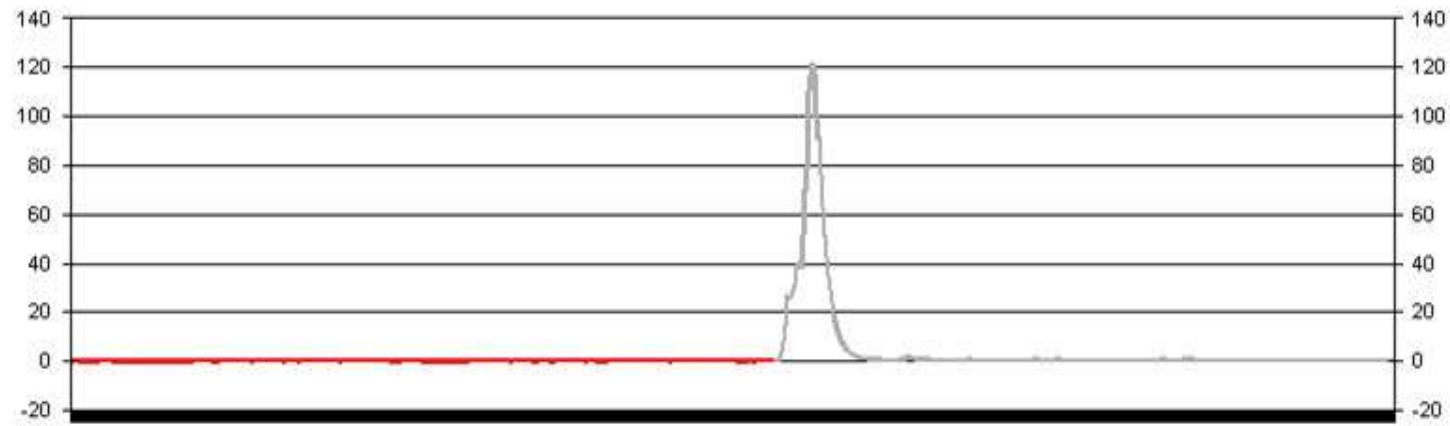
Other Applications

- The Centre for Public Health Research worked with the Department of Labour in May 2011 to carry out video exposure monitoring on a home-construction site measuring exposure to silica-containing dust from skill-sawing Hardie linea[®] board.
- Over a 2 hour period of sampling, measured 20 instances where peak levels ranged from 1.68 to 210.01 mg/m³.





Sample time	Reading	Trigger thre
2:04:34 p.m.	0.13	
2:04:35 p.m.	0.15	
2:04:36 p.m.	0.15	
2:04:37 p.m.	0.15	
2:04:38 p.m.	0.15	
2:04:39 p.m.	0.22	
2:04:40 p.m.	1.07	
2:04:41 p.m.	3.63	
2:04:42 p.m.	7.75	
2:04:43 p.m.	14.41	
2:04:44 p.m.	26.07	
2:04:45 p.m.	25.67	
2:04:46 p.m.	26.28	
2:04:47 p.m.	28.23	
2:04:48 p.m.	30.92	
2:04:49 p.m.	37.99	
2:04:50 p.m.	39.74	
2:04:51 p.m.	38.49	
2:04:52 p.m.	38.55	
2:04:53 p.m.	51.08	
2:04:54 p.m.	69.56	
2:04:55 p.m.	78.38	
2:04:56 p.m.	109.99	
2:04:57 p.m.	116.11	
2:04:58 p.m.	121.48	
2:04:59 p.m.	117.95	
2:05:00 p.m.	99.43	
2:05:01 p.m.	91.35	
2:05:02 p.m.	91.39	
2:05:03 p.m.	77.15	
2:05:04 p.m.	62.97	
2:05:05 p.m.	51.63	
2:05:06 p.m.	42.91	
2:05:07 p.m.	35.16	
2:05:08 p.m.	29.37	
2:05:10 p.m.	24.09	

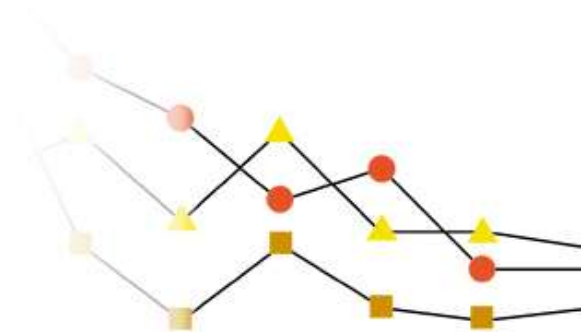


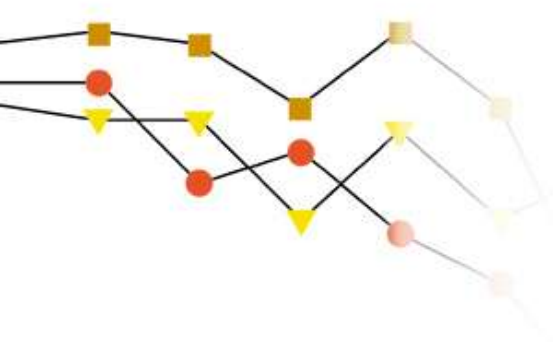
Play Pause Stop



Other Applications

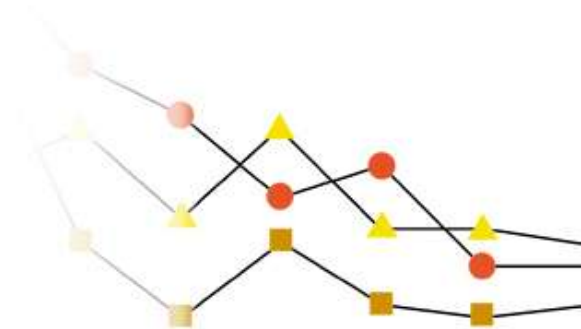
- The Centre for Public Health Research worked with the Department of Labour in May 2011 to carry out video exposure monitoring on a home-construction site measuring exposure to silica-containing dust from skill-sawing Hardie linea[®] board.
- Neurotoxic effects of occupational solvent exposure will use VEM to assess whether the acute and/or chronic effects are associated with peak or average exposure levels.
- Residual fumigants in shipping containers
 - Safework Australia
 - Melbourne
 - Using VEM to measure real time exposure to methyl bromide in small businesses with fumigated shipping containers
- A Year in the Life of a Farmer
 - Victoria and NSW
 - Using VEM to measure temperature, UV, noise and dust exposure

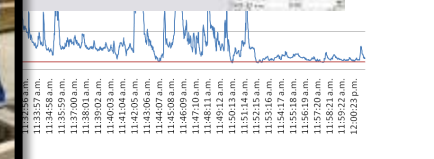
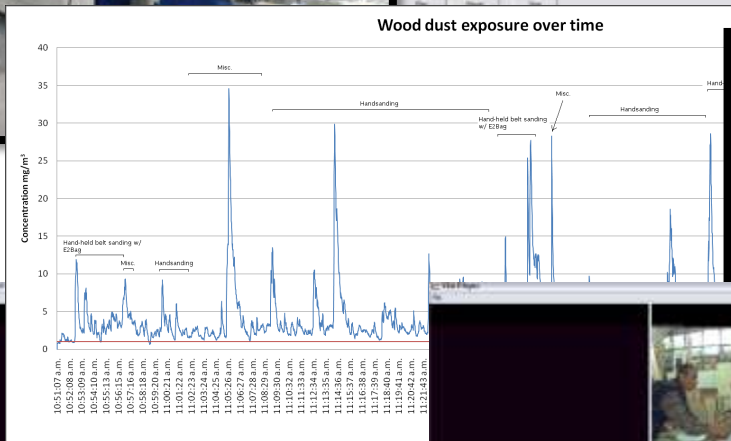
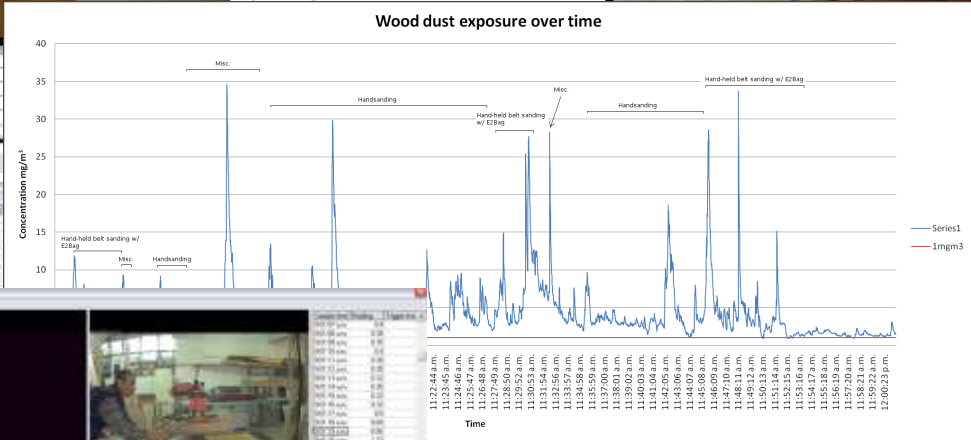




Conclusion

- A system which measures many different types of exposures at the same time.
- Gives insight into what, when, where, why, and how workers are being exposed.
- VEM adds to the 8-hour TWA to give researchers the knowledge to help reduce exposure, understand hazards and educate workers.
- Safer workplaces, cost savings, healthier workers, and reduced mortality.
- High priority for VEM to be further developed, used, and made more widely available.





Time	Concentration (mg/m³)
11:23:45 a.m.	10
11:24:46 a.m.	10
11:25:47 a.m.	10
11:26:48 a.m.	10
11:27:49 a.m.	10
11:28:50 a.m.	10
11:29:51 a.m.	10
11:30:52 a.m.	10
11:31:53 a.m.	10
11:32:54 a.m.	10
11:32:56 a.m.	28
11:33:57 a.m.	10
11:34:58 a.m.	10
11:35:59 a.m.	10
11:36:00 a.m.	10
11:37:01 a.m.	10
11:38:02 a.m.	10
11:39:03 a.m.	10
11:40:04 a.m.	10
11:41:05 a.m.	10
11:42:06 a.m.	10
11:43:07 a.m.	10
11:44:08 a.m.	10
11:45:09 a.m.	10
11:46:10 a.m.	10
11:46:09 a.m.	32
11:47:10 a.m.	10
11:48:11 a.m.	10
11:49:12 a.m.	10
11:50:13 a.m.	10
11:51:14 a.m.	10
11:52:15 a.m.	10
11:53:16 a.m.	10
11:54:17 a.m.	10
11:55:18 a.m.	10
11:56:19 a.m.	10
11:57:20 a.m.	10
11:58:21 a.m.	10
11:59:22 a.m.	10
12:00:23 p.m.	10

Time	Concentration (mg/m³)
10:51:07 a.m.	5
10:52:08 a.m.	10
10:53:09 a.m.	5
10:54:10 a.m.	10
10:55:11 a.m.	5
10:56:13 a.m.	5
10:57:14 a.m.	5
10:58:15 a.m.	5
10:59:16 a.m.	5
11:00:17 a.m.	5
11:00:21 a.m.	5
11:01:22 a.m.	5
11:02:23 a.m.	5
11:03:24 a.m.	5
11:04:25 a.m.	5
11:05:26 a.m.	5
11:06:27 a.m.	5
11:07:28 a.m.	5
11:08:29 a.m.	5
11:09:30 a.m.	5
11:10:31 a.m.	5
11:11:32 a.m.	5
11:12:34 a.m.	5
11:13:35 a.m.	5
11:14:36 a.m.	5
11:15:37 a.m.	5
11:16:38 a.m.	5
11:17:39 a.m.	5
11:18:40 a.m.	5
11:19:41 a.m.	5
11:20:42 a.m.	5
11:21:48 a.m.	5

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11:23:45 a.m.	10
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11:28:50 a.m.	10
11:29:51 a.m.	10
11:30:52 a.m.	10
11:31:53 a.m.	10
11:32:54 a.m.	10
11:32:56 a.m.	28
11:33:57 a.m.	10
11:34:58 a.m.	10
11:35:59 a.m.	10
11:36:00 a.m.	10
11:37:01 a.m.	10
11:38:02 a.m.	10
11:39:03 a.m.	10
11:40:04 a.m.	10
11:41:05 a.m.	10
11:42:06 a.m.	10
11:43:07 a.m.	10
11:44:08 a.m.	10
11:45:09 a.m.	10
11:46:10 a.m.	10
11:46:09 a.m.	32
11:47:10 a.m.	10
11:48:11 a.m.	10
11:49:12 a.m.	10
11:50:13 a.m.	10
11:51:14 a.m.	10
11:52:15 a.m.	10
11:53:16 a.m.	10
11:54:17 a.m.	10
11:55:18 a.m.	10
11:56:19 a.m.	10
11:57:20 a.m.	10
11:58:21 a.m.	10
11:59:22 a.m.	10
12:00:23 p.m.	10



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 - To HRC,ACC and DoL for funding.
 - To all participants and managers of the studies.
 - To all collaborators, investigators and field workers.

- And thank you all for listening!

