



Aalto University
School of Engineering

Universal clip-on for emission meters in worker's breathing zones

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Background

- **Project with Työterveyslaitos (Finnish Institute of Occupational Health) and Helsinki University 2015-2016**
- The aims of this project was:
 - To produce information about the state of work hygiene in the 3D-printing industry
 - To estimate workers exposure to particles and gas phase compounds
 - To use the measurement data in improving the indoor model
 - To produce guidelines how to work safely with 3D-printers
- Aalto provided the 3D printing knowledge, TTL the health and measurement aspect, HY indoor modeling knowledge.

So basically 3D printers emit particles, we went and measured how much, what kind and in what kind of situations.

One of the things we measured was what users' of 3D printers breath in.

Why measure what workers breath in?

The **breathing zone** is the area immediately surrounding a worker's nose and mouth (15-25cm).

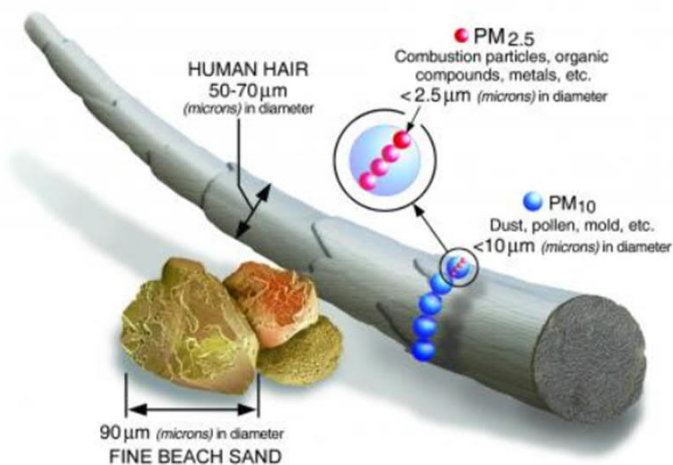
The purpose of air sampling in a worker's breathing zone in the workplace is to ensure that employees are not exposed to dangerous levels of airborne contaminants such as dust, biological agents, or toxic chemicals.

These two things matter:

- level of exposure
- length of time exposed

This is something that is very important in industries from food industry to mining industry.

Size matters!



Size comparisons for PM particles

PM₁₀ (<10 μm) **Not Good**

- Inhalable Particles
- Deposit in the extra thoracic/upper tracheo-branchial region

PM_{2.5} (<2.5 μm) **Bad**

- Fine Particles
- Deposit in deeper lungs

PM_{0.1} (<0.1 μm) **Really Bad**

- Ultra-fine particles
- Pass into the circulatory system

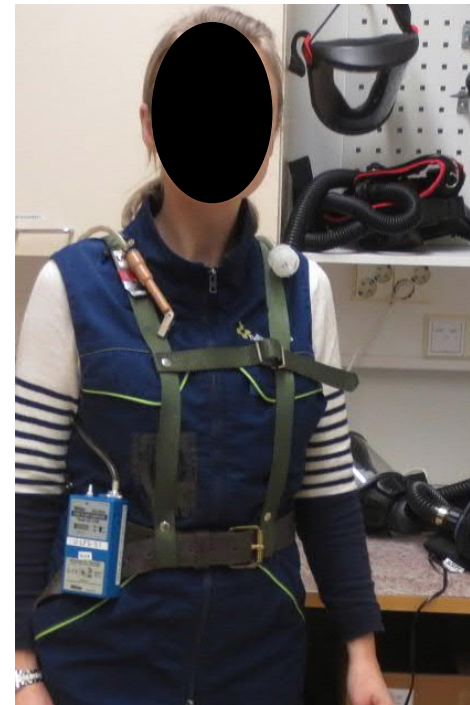
Source: <https://www.epa.gov/pm-pollution/particulate-matter-pm-basics>



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**So what is the
problem?**

You try to strap meter(s) to a person, and then they try to work normally.



Why is this difficult?

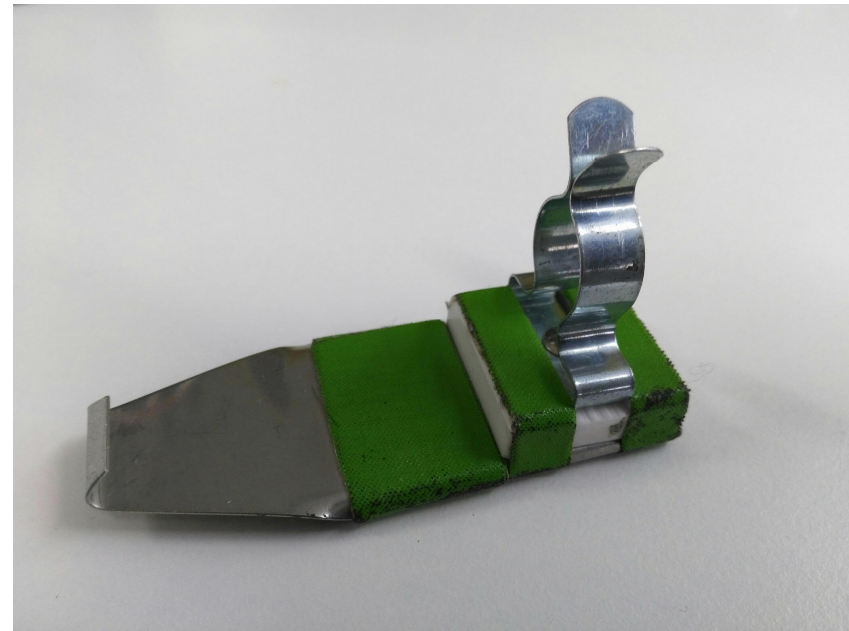
Based on two interviews:

- Different meters, different ways to attach it
- Sometimes you want to use two meters at the same time
- Body sizes vary quite a lot
- Level of safety gear varies a lot too
- No universal harness, or clip-on.
- Tape and zip-ties are often used (unprofessional and unhygienic).
- Equipment should be firmly attached to the worker



Main issues to work with

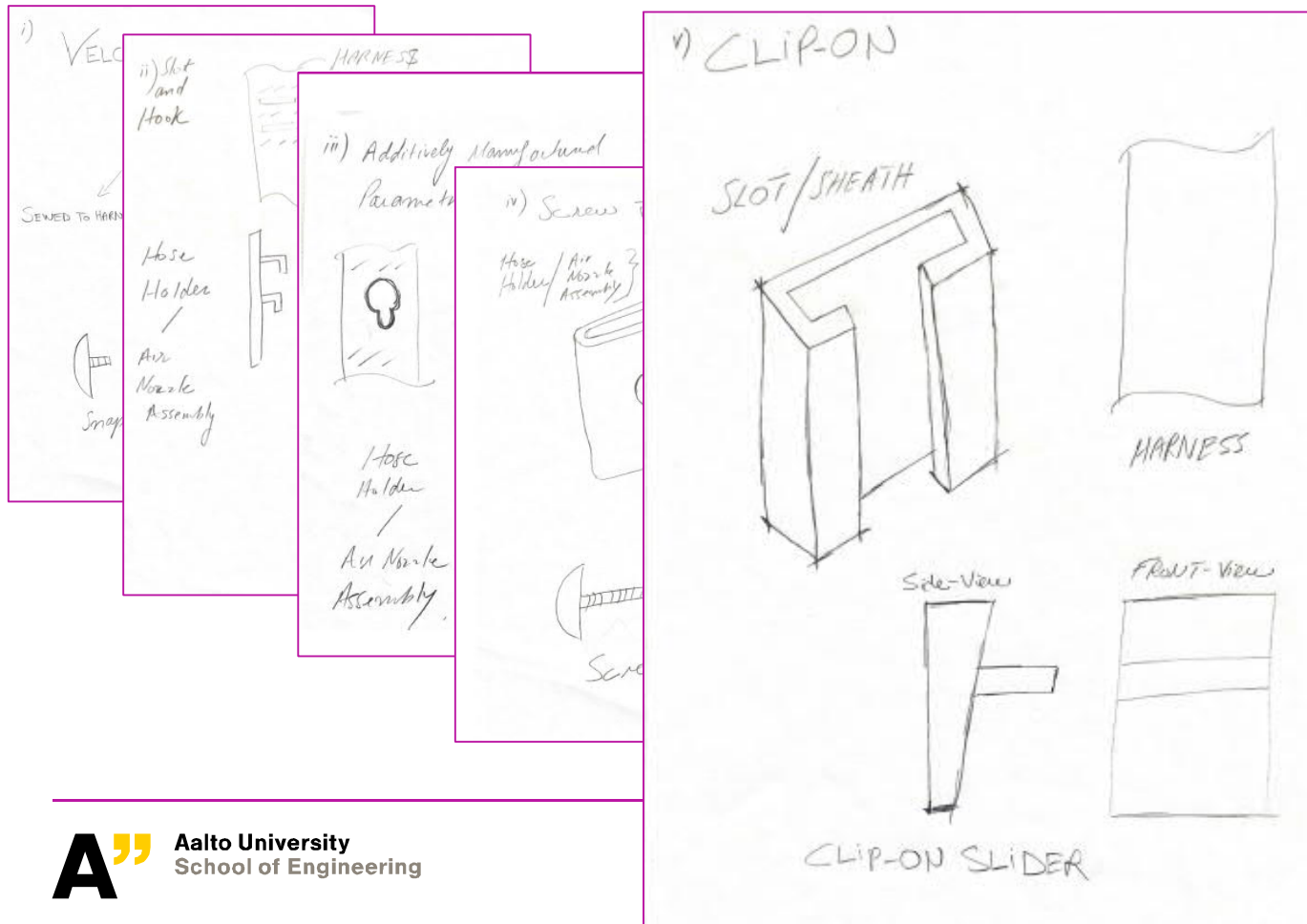
- **Universal clip-on/ hose holder**
- **Excessive hose problem (safety issue)**
- **Powder sampler clamping problem**
- **Universal harness**



Why 3D printing?

- **Current solution is inefficient**
- **Current solution is custom made (expensive and not easily available/changed)**
- **Replacing tape and the zipties**
- **Hygienic purposes (corrosion)**
- **Adjustable placements of different tools**
- **Parametric/customizable model of novel design**

Steps towards the solution...



Steps toward the final product

- **Making the model**
- **Printing**
- **Evaluating the solution together with TTL**
- **Improving the solution**
- **...**
- **Printing the final solution**