WOOD DUST

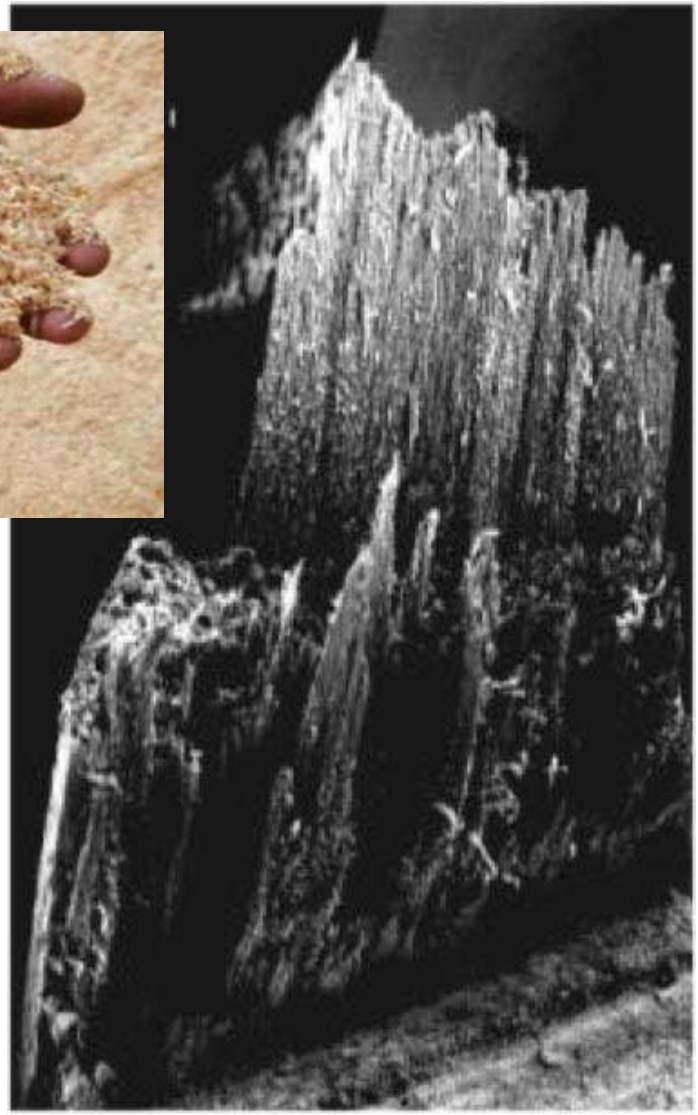
Presentation by **Bob Loss**

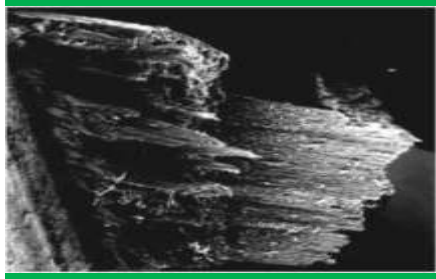
March 2013 FWWA meeting

Fine Wood Work Association
Western Australia

Introduction

Below is a picture of what we commonly think of as wood dust. We can see and feel it and it is nuisance in our workshops in that it clogs machinery and makes floors slippery. It also makes us sneeze and somewhere along the way you may have heard that it is not that good for you.





Wood Dust

In a handful of sawdust most of the particles of sawdust are so small as to be invisible. These invisible particles can be magnified up with a microscope and guess what?– they look just like big bits of sawdust (See photo on right).

One big difference between big and small dust particles is their ability to enter our bodies. But before discussing this, just how small are we talking about?

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Wood Dust Particle Sizes

The picture below shows the sizes involved. As a point of reference I will use a human hair which is typically 70 microns (0.07 mm) in diameter. Wood dust covers the range from millimetres down to less than 0.1 microns. The labels PM in the diagram refer to Particulate Matter, so PM_{10} means particles smaller than 10 microns.

The health problems caused by small wood dust particles are almost certainly related to the degree of penetration possible by the smaller particles. The diagram on the next page shows the sizes of particles typically lodged in airways. Particles larger than about 10 microns do not remain suspended in air for long so it is the 10 to

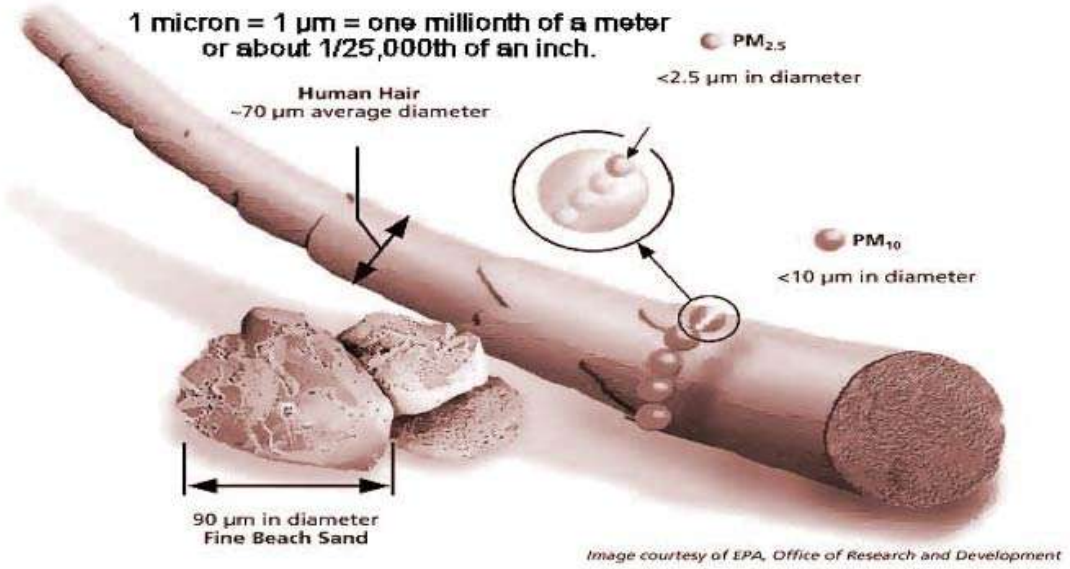
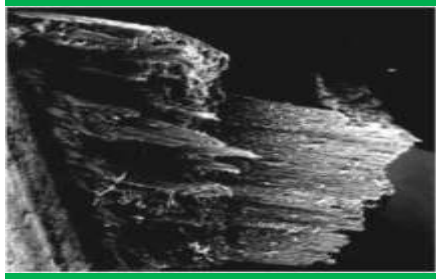


Image courtesy of EPA, Office of Research and Development

The unassisted human eye cannot see particles smaller than about 10 microns, and for people over 50 years of age even larger. While most of the weight of wood in sawdust will be in the visible particles, most of the particles will be to small to see; and a potential health problem is that it is the smaller particles that are most likely to cause health problems.

less than 1 micron sizes that can enter airways. Here they lodge and release irritants which can eventually cause serious health problems, the most common being cancers in the upper respiratory tract, but stomach cancer rates are also elevated amongst wood workers.



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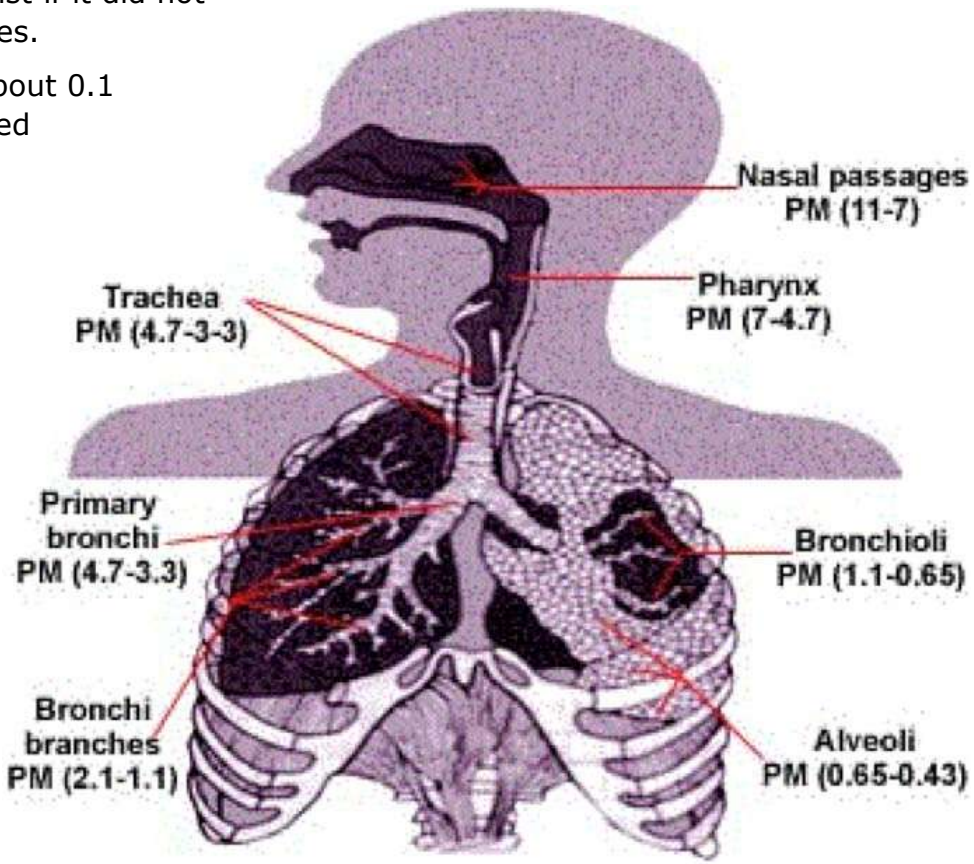
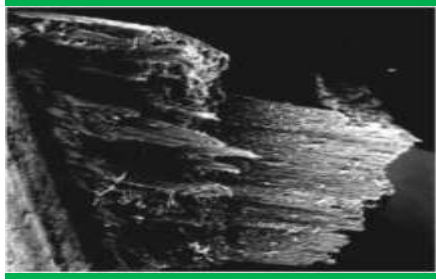
Wood Dust Particle Sizes (cont'd)

Wood dust has been on the USA National Institutes of Health list of 200 recognised materials and chemicals likely to cause cancer, since 2002. It would not be on this list if it did not concern health authorities.

Particles smaller than about 0.1 micron are not considered a problem as they stay suspended in air and are easily breathed out again.



Disposition of Particulate Matter (PM) in the Respiratory system (Richard Wilson, Harvard Press,1996)



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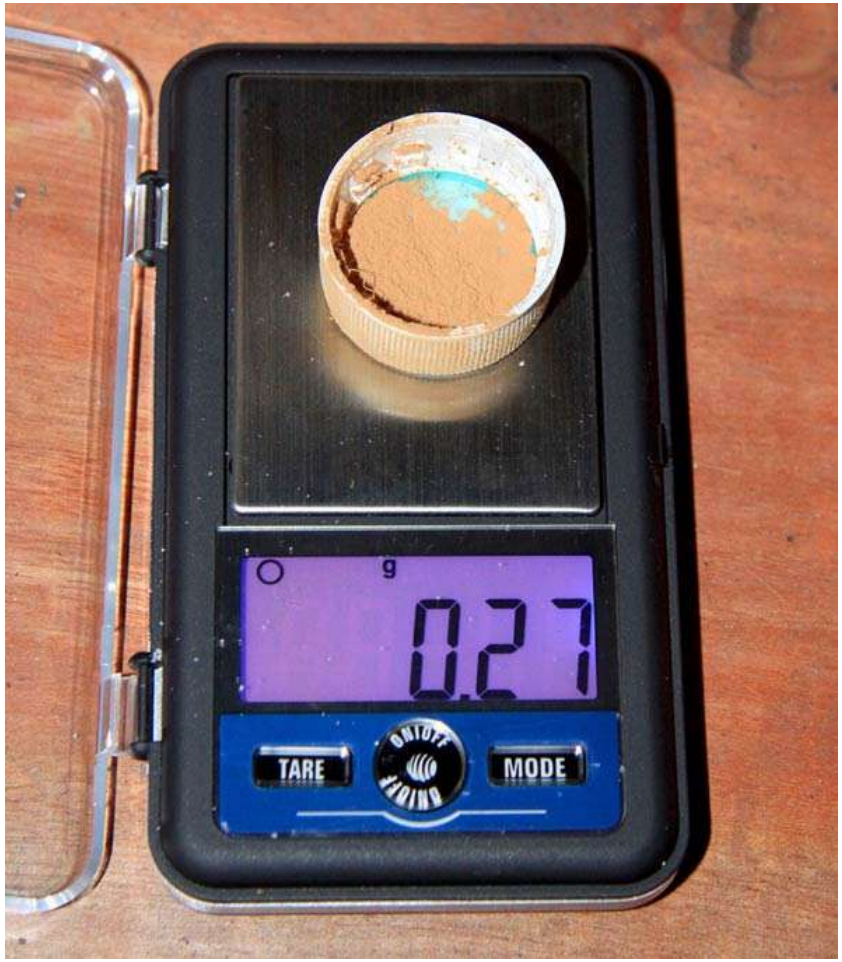
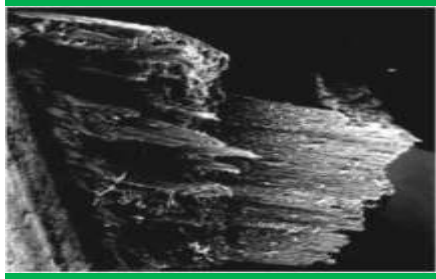
Wood Dust Particle Sizes (cont'd)

The next question is "How much dust is too much"? In terms of Australian OHS standards, the most common standard (and considered by some health authorities as too high) for wood dust is 5 milligrams of dust in one cubic metre of air (5 ppm) for softwoods and 1 ppm for hardwood; but what does this mean in practice?

In the picture a soft drink bottle cap contains a pinch of fine hardwood dust that weighs 0.27g. This much dust suspended in air is enough to contaminate four sheds, each 6 x 4 m, to above the 1 ppm OHS standard. As Bill Pentz (at *billpentz.com :* Cyclone and Dust Collection Research) says this is less than the amount of dust a wood worker might shake off their shirt at the end of a working day.

The 1 ppm for hardwood standard is not very useful because it does not say what size of particles this is for. More recent European standards now specify sizes. In terms of the wider community European standards specify a standard of 0.1 ppm for PM_{10} airborne dust.





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Wood Dust Exposure by Occupation

Next we will look at what woodworking occupations generate dust. The table shows the industry or job group and typical exposure in mg/m^3, which is the same as ppm.

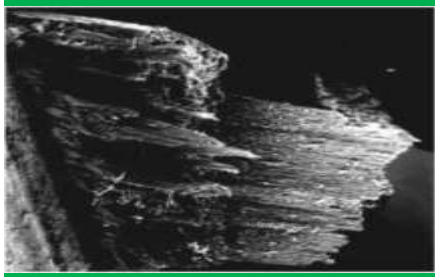
Construction carpenters are exposed to the widest range of dust, presumably because they work across a wide range of locations, from the wide outdoors to inside small walk-in cupboards. The next most exposed groups are turners, whose minimum exposures are above the OHS standard, but most groups are at risk especially given that the 1ppm OHS standard is considered too high.

Industry or Job group	N	Mean (mg/m^3)	Min. (mg/m^3)	Max. (mg/m^3)
ALL Furniture	496	7.22	< 0.02	286
Lathe operator	11	33.1	1.43	286
Sander, nec	127	10.5	< 0.02	131
Cabinet maker	21	5.74	0.3	15
Sander, hand	23	7.88	0.14	65.4
Wood worker	20	10	0.5	58.4
Router operator	13	5.66	0.48	28.3
Saw operator, nec	26	4.21	< 0.02	27.7
Saw operator, rip	11	0.71	< 0.02	1.61
Vocational instructor	18	0.72	< 0.02	4.25
Construction carpenter	12	47.3	0.05	538

N is the number of wood working sites surveyed.

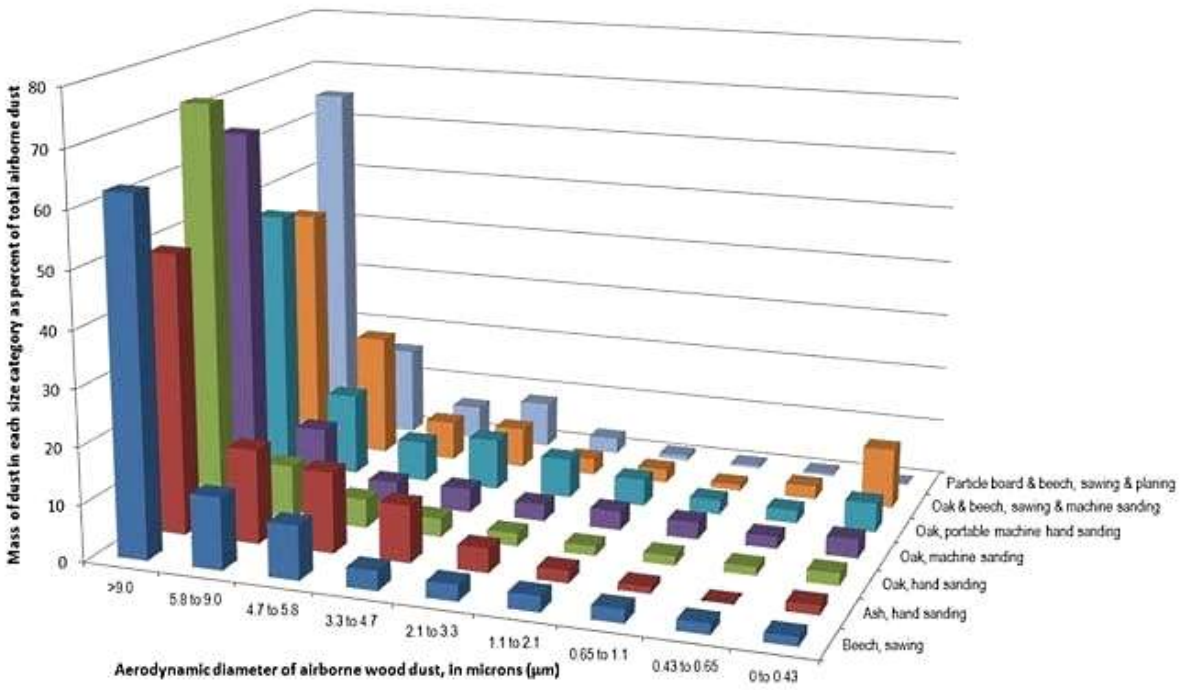
Wood Dust Particle Sizes by Activity

The diagram on the next page presents a chart showing the amounts of dust produced by various wood working activities on different timbers. Fortunately most of the weight of the particles is in the heavier, larger, less dangerous particles. Perhaps not unexpectedly the one activity that stands out as producing small particles is sanding.



Wood Dust Particle Sizes by Activity (cont'd)

Particle size distribution of wood dust from various operations on different hardwoods
(After: Lehmann E., and Fröhlich N., 1988. Particle size distribution of wood dust at the workplace. *J. Aerosol. Sci.* 19:1433–35.)

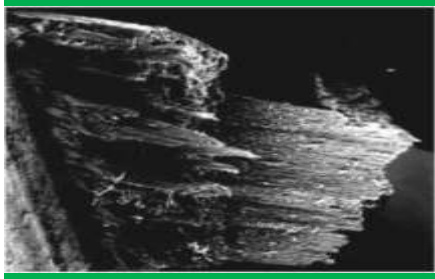


While diagrams like that above may seem reassuring, unfortunately tiny particles weigh very little so even a few percent of the total weight can still represent millions of particles per cubic metre.

The diagram on the next page charts the numbers of wood dust particles suspended in air after sweeping a wood working shed, and what happens to the numbers over time after sweeping. The amount of sawdust on the floor was low in that the floor underneath could still be clearly seen.

The various coloured lines refer to the different particle size ranges, eg. the "0.3–0.5" refers to particles in the 0.3 to 0.5 micron particle size range. The left hand vertical axis shows the number of particles and the X-axis shows time in minutes.

The line labeled "Conc" shows the concentration of wood dust in the air in ppm and refers to the right hand vertical axis.



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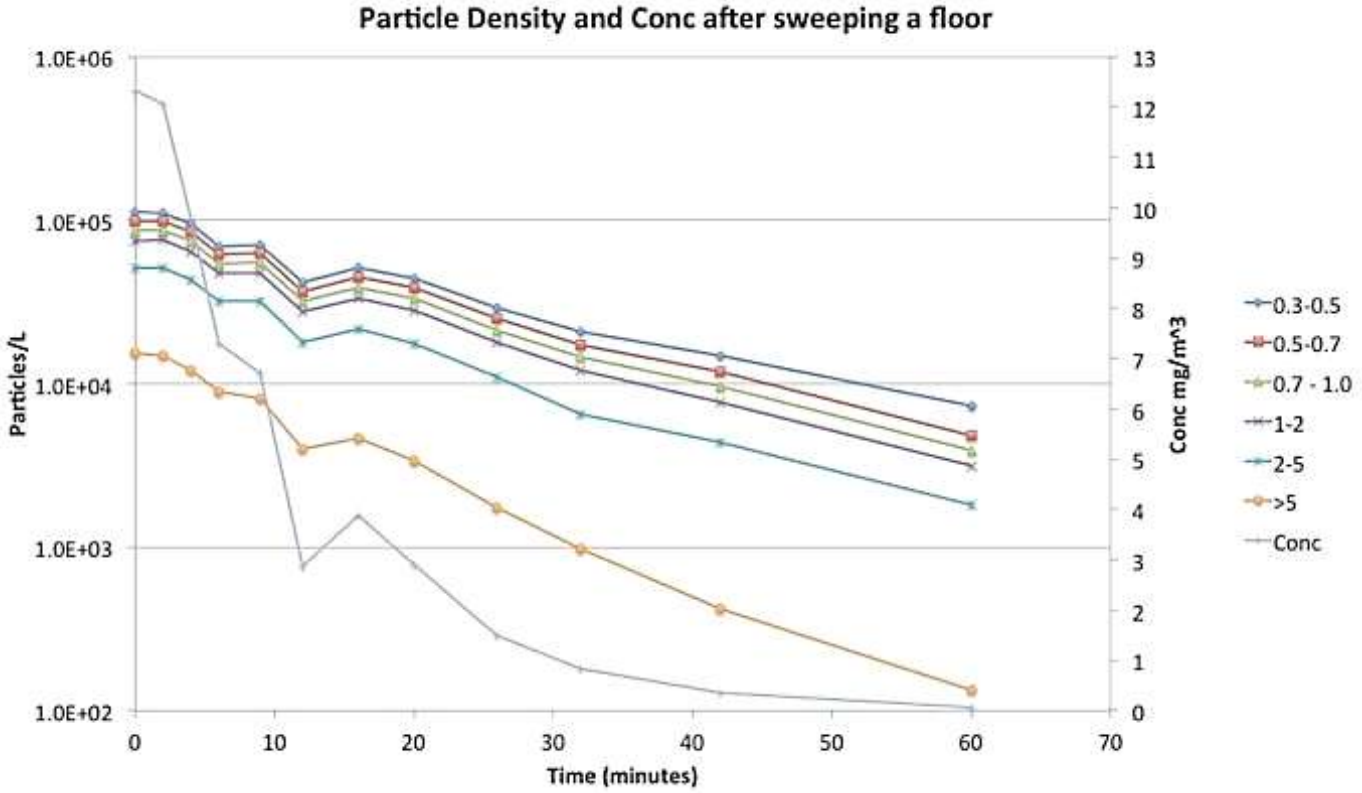
Wood Dust Particle Sizes by Activity (cont'd)



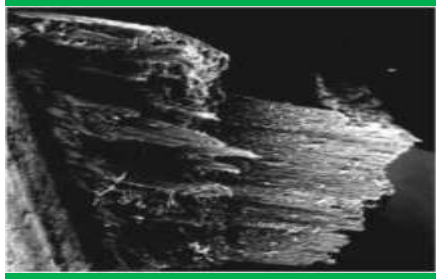
There is a lot of information on the chart.

Firstly it shows the very large number of smaller particles compared to the larger particles present in the saw dust.

Next the "Conc" line shows that in this case just sweeping the floor increased the concentration of wood dust in the air to about 12 time the OHS standard, and it then takes about 30 min to get to below the 1 ppm OHS standard.

The larger particles (>5 microns) drop off a lot more quickly (about twice as fast) than the smaller ones.

This data demonstrates why dust collectors should be left running for some time after the last dust making activity as wood dust invariably escapes from all dust collection.



WOOD DUST

How to Effectively Collect Wood Dust

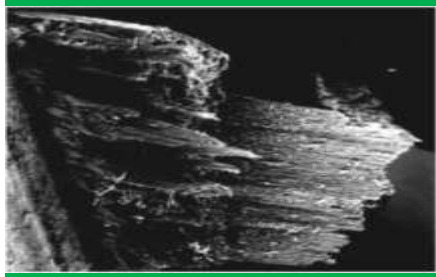
Over many years of experience dust veterans like Bill Pentz have come up with some clear guidelines for managing wood dust.

From here on I will use the following abbreviations:

DC = Dust collector,
HP = Horsepower,
FPM = ft /min.
VC = Vacuum Cleaners,
CFM = cubic ft/min,

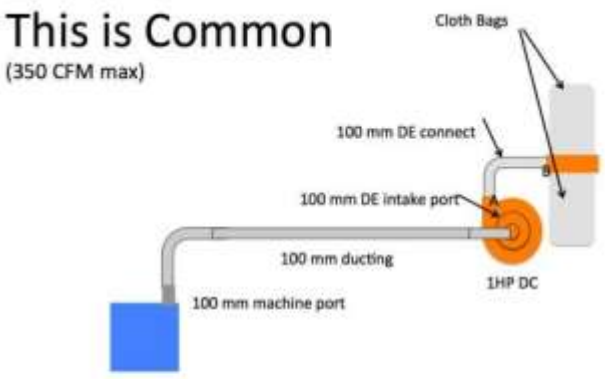
To capture and vent invisible dust:

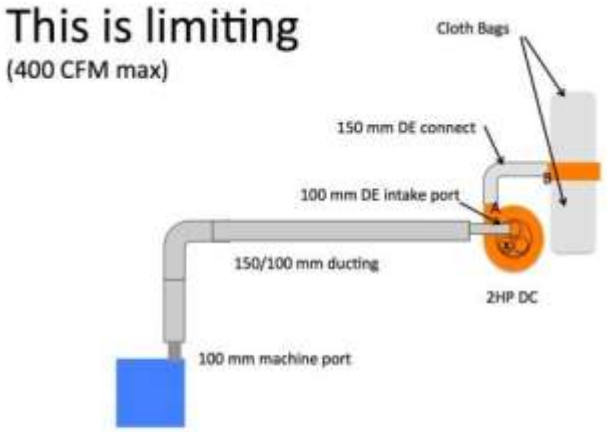
- Use dust collectors that capture 1,000 CFM, with ducting air speeds of 4,000 FPM for machinery. This is the only way to ensure most of the fine dust is collected at source, otherwise it escapes into the shed.
- Don't believe manufacturers' specs on air flow (most are ~50% too high).
- Air flow, or CFM, is primarily related to DC power, DC impeller size, and is limited by ducting and DC/Machine port size; ie. 6" ducting and ports required
- The size of ducting is CRITICAL – narrow ducts will choke the flow, with the maximum flow possible for a
  2" diam duct =120 CFM,
  4" = 420 CFM,
  6" = 1250 cfm.
- 1 HP DC is too weak – a min of 2 HP, preferably 3HP or more.
- VCs are rarely appropriate for dealing with dust generated by machines.
- Well designed large cyclones are very useful, but $$$.
- 3 x 4" ports are required to equal 1 x 6" port for air flow.
- Short ducting lines, smooth long radius junctions.
- Biggest problem is DC LEAKS.
- Total capture and retention inside a shed is difficult – if possible vent your DCs outside.

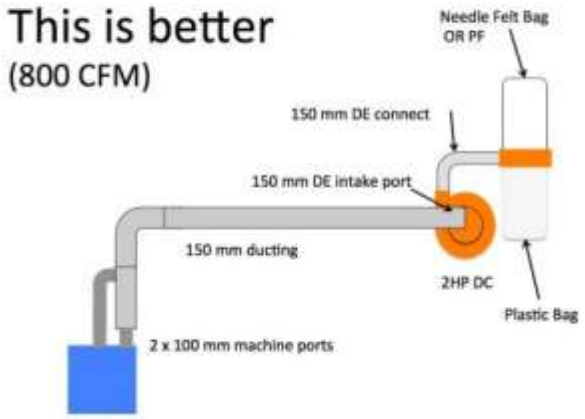


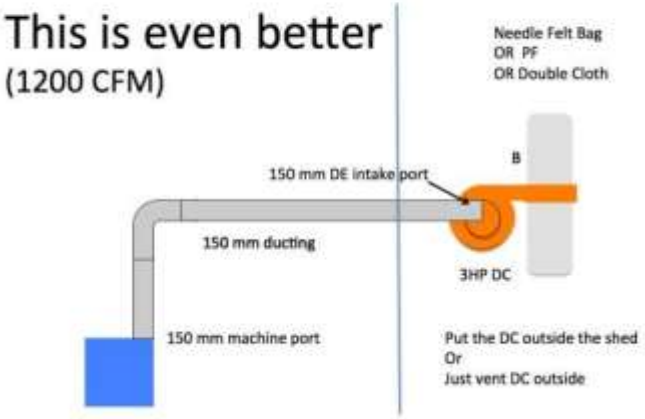
Dust Collectors

Most small and even larger DCs and woodworking machines are very poorly designed for dust collection .

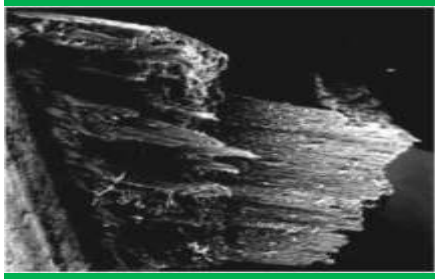








In the diagram above you can see that typical 1HP systems using 100 mm dust ports and ducting will struggle to generate 350 CFM. While such systems may look like they collect all the sawdust the reality is they will not collect much of the invisible dust at source.



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Dust Collectors (cont'd)

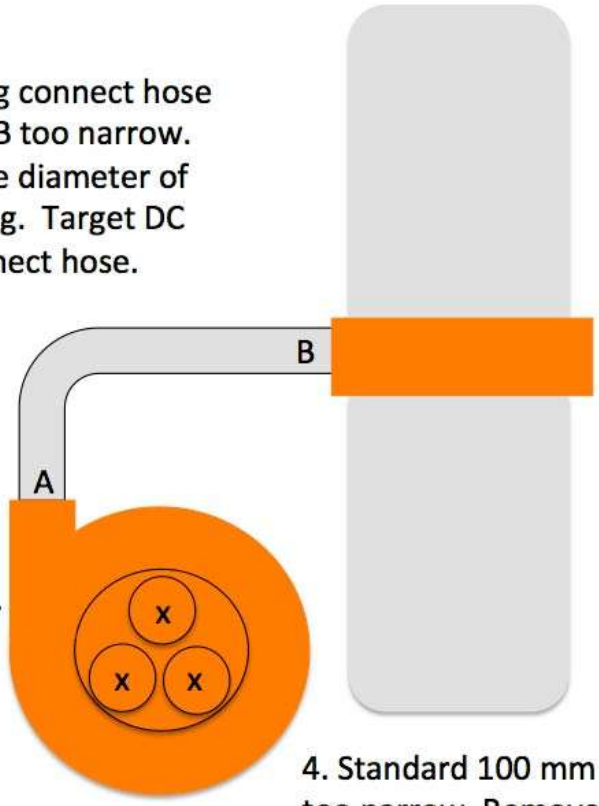
Just using bigger ducting is not sufficient as all the choke points in the system need to be addressed. This includes ducting size, dust port sizes on machines and the connection of the DC impeller to the collection bags.

To generate 1200 CFM a 3HP DC is needed, the dusting MUST be 150 mm in diameter and the machine dust ports MUST be 150 mm in diameter and the machine may need to be opened up to facilitate air flow.

Below is a general summary about dust collectors.

1: Impeller to bag connect hose and ports A and B too narrow. Should match the diameter of the intake ducting. Target DC without any connect hose.

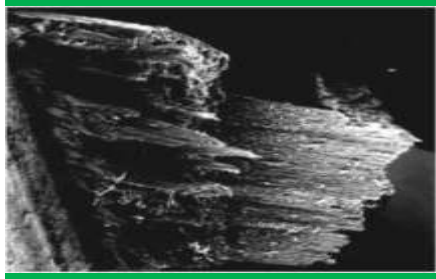
2: Bags are restrictive and get more restrictive as they get dirtier. More bags, pleated filters or a well designed Cyclone are better.



3: Machine Ports Too small / too restrictive – open up so machine can breathe

5: 2850 rpm impeller speed, consider using 3 Phase and using a VFD to generate 3600 rpm.

4. Standard 100 mm impeller intakes (x) are too narrow. Remove intakes completely and/ or open up impeller intake to match larger ducting size.



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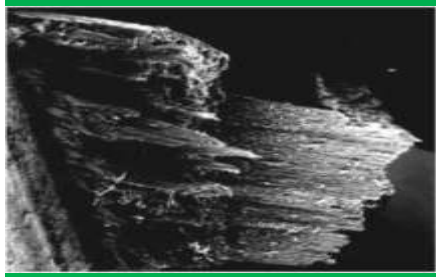
Ports and Hoods

Most dust collection kits provide very poor dust collection performance, with dust hoods and ports that are poorly designed. For example dust collection hoods for lathes work best when using something like the bell mouth hood shown below.

The effect of the bell mouth hood is to forward project the point of highest air speeds, which enable the fine dust to be grabbed right where it is generated. Most turners focus on chip collection, but these will not hurt you compared to the fine dust



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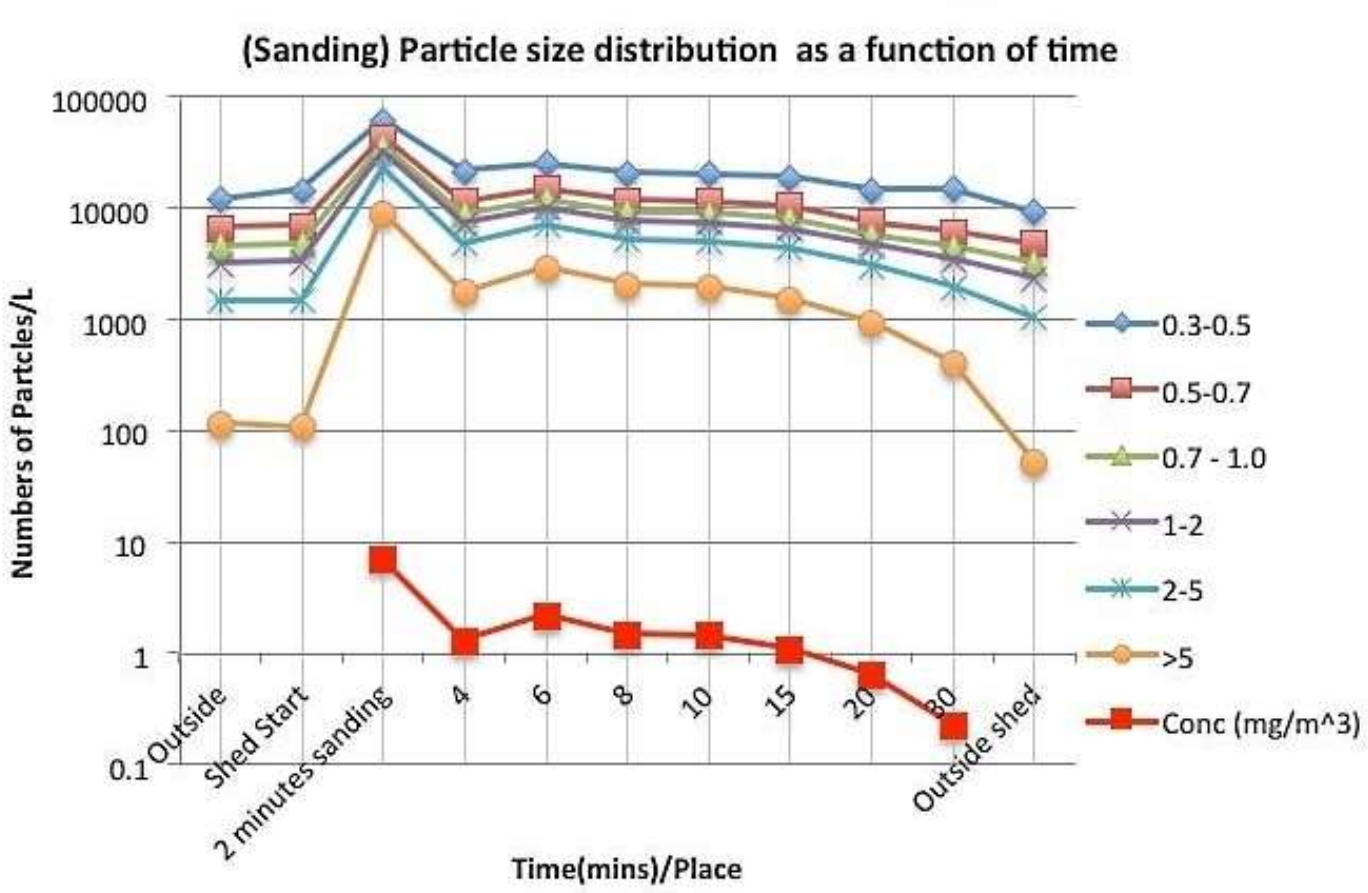
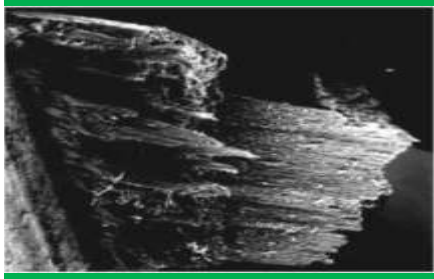
Ports and Hoods (cont'd)

The chart below show typically what happens when sanding for just two minutes on a woodworking lathe without any dust collection. In this case all data for numbers of particles and concentration refer to the left hand side axis.



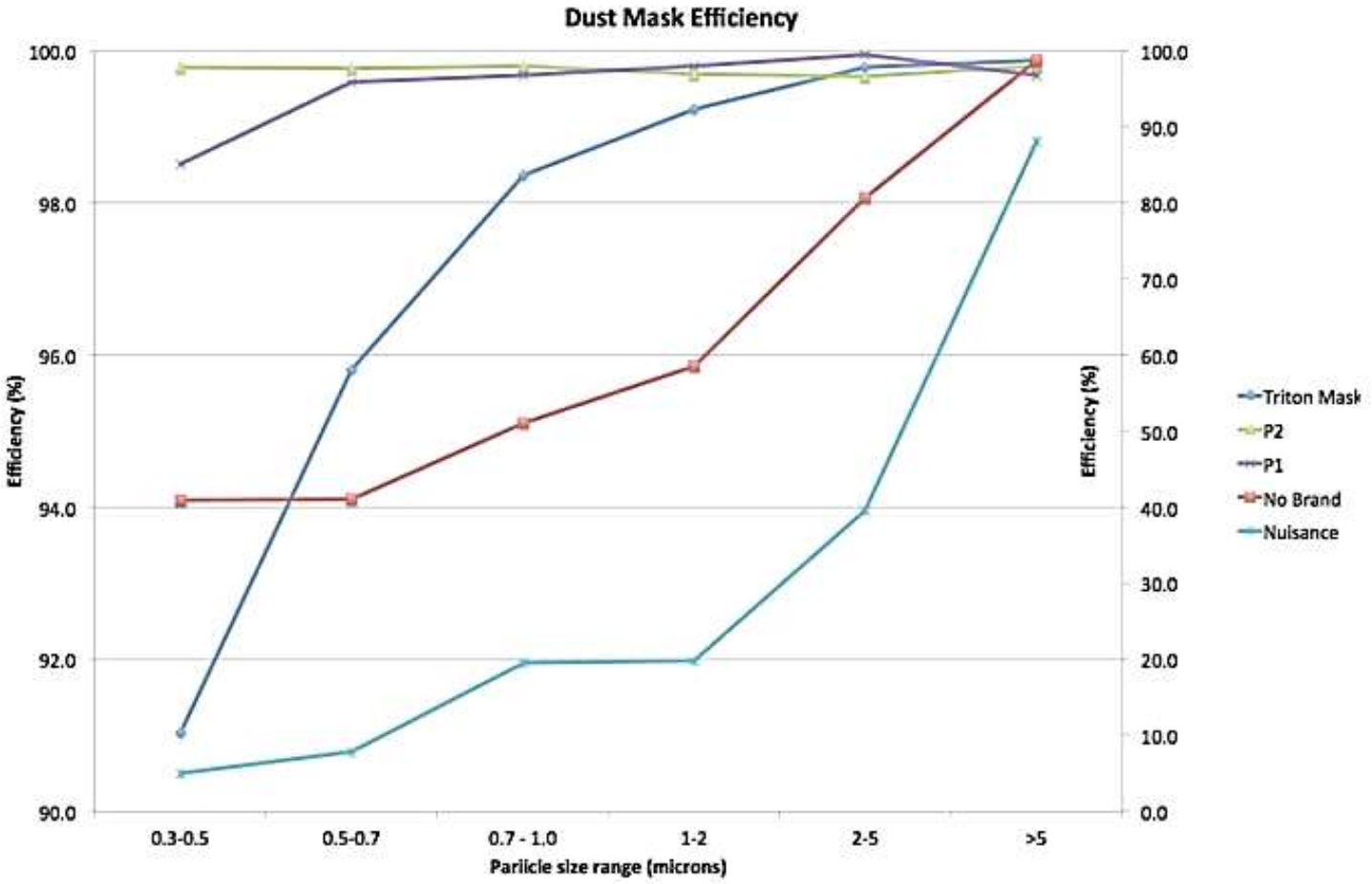
The red line shows that two minutes of sanding sends the levels of dust in the shed well over the OHS standard. It then takes at least 15 minutes for the dust levels to fall below the OHS standard. If a bell mouth hood and 3HP DC is used the levels never go above the OHS standard. The chart shows a case of no DC – when a bell mouth hood is used during sanding the dust levels remain the same as the shed background level.

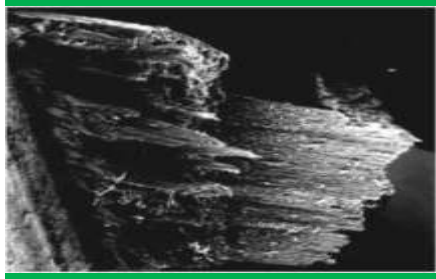


Dust Masks

Most dust masks use effective media but the limitation is poor fitting to holders and faces. The chart below shows some percentage efficiency of filtration for P1, P2 masks (these refer to the left hand side axis) which are typically better than 98% for even the finest particles.

The Triton full face mask uses a P2 type filter, but the fitting of the media in the Triton filter holder reduces the efficiency of the filter. When filters are fitted to faces this becomes much worse. The other two lines refer to cheap masks – these have very poor efficiencies (refer to right hand vertical axis) and should not be used.





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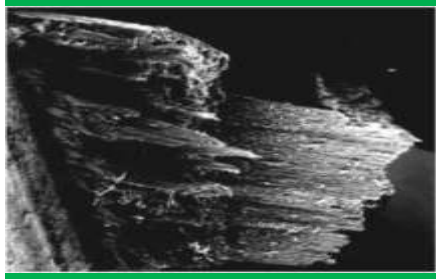
Other Dusts

Finally I would like to mention that we should not just be worried about wood dust as many other forms of dust in our sheds have health implications, grinding, welding and spay painting being just a few that come to mind. Good ventilation is one way to deal with this, but I was so concerned I made and installed a fume hood with 500 CFM extraction and it is very effective.

Summary

On the following page is a summary of how to effectively control Dust in your shed.

Biographical Note	Until recently Dr Robert Loss was an Associate Professor in the Physics Department at Curtin University and has been involved with designing and building dust free laboratories for over 30 years. Bob is happy to answer questions about wood dust and to advise members on their dust collection setup. His email is r.loss@iinet.net.au



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Bob's DC made simple

Device	Recommendation	Comment
Minimum ducting diam	6"	Keep length to minimum
Minimum DC HP	3"	Regular maintenance required
Minimum DC intake port	6" or multiple 4"	Some surgery to enlarge ports may be required
DC vent location	Outside shed	Well away from major opening to shed
DC bags	Depends on location of DC	Use plastic for bottoms
Pleated filters	Depends on location of DC	Only necessary when external DC venting not possible
Cheap vacuum cleaner	Not recommended	Regular cleaning and maintenance required
Genuine HEPA filter vacuum cleaner	Recommended on power tools only	Regular cleaning and maintenance required
Chip collector / dust trap / Small cyclone	Not recommended	Increases back pressure flow – can help keep filters clean for longer
Large cyclone	Yes	Expensive
Flexible ducting	Avoid	Keep length to absolute minimum for connections
Ducting connections	Keep to minimum	Eg. Use two 45° bends instead of one 90° bend
Machine port size	Should match ducting size	Some surgery to enlarge ports may be required
Auto machine / DC switch	Not recommended	Run DC for 15–20 minutes after last dust making activity
Mask	Recommended	In addition to DC or when nothing else available – use quality mask
Ventilation	Recommended	Cross-wise is much better than not