Exemplar for Internal Achievement Standard

Technology Level 1

This exemplar supports assessment against:

Achievement Standard 91059

Demonstrate understanding of basic concepts used to make products from resistant materials

An annotated exemplar is an extract of student evidence, with a commentary, to explain key aspects of the standard. These will assist teachers to make assessment judgements at the grade boundaries.

New Zealand Qualification Authority

To support internal assessment from 2014

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1. For Excellence, the student needs to demonstrate comprehensive understanding of basic concepts to make products from resistant materials.

This involves:

- discussing why resistant materials require particular techniques for their safe handling and use
- discussing why techniques and resistant materials are combined in different ways across two or more situations.

Comprehensive understanding is demonstrated by referring to concepts that relate to a cabinet that the student made.

The student discusses why a range of materials such as pinus radiata, MDF, rimu and teflon require particular techniques for their safe handling and use (1). The discussion describes a range of material characteristics (1).

The student compares and contrasts some combinations of techniques (marking out, cutting, joining and finishing) and materials (pine, rimu, MDF) (2) (3).

To meet the requirements of Excellence more securely, the student could compare a broader range of materials and techniques in other situations (perhaps including situations outside of their own practice), i.e. metals or composites. This advances the opportunity for the discussion required at this level.
Characteristics

My project is a cabinet with drawer and a native timber trim and is made from untreated pinus radiata (pine), recycled rimu, and MDF (Medium Density Fibreboard). I chose different timbers for their different colours and their availability and for the different places in the cabinet. Untreated pinus radiata is inexpensive and you can get it in wide boards, and it has an attractive grain. This mean that it was easier to get the width I needed for my cabinet with less joins. I used MDF for the drawer because it is very stable compared to pine but not the drawer front as I wanted an attractive face. I used recycled heart rimu for the trim colour I needed for the cabinet top and the skirting around the base. It also provides a harder edge for the cabinet top. I used Teflon for the drawer runners because it is so hard and also very slippery for the drawer to slide.

Pinus radiata is less dense than rimu with a density of less than 400 kilograms per cubic metre whereas rimu is 600 kilograms per cubic metre. Pine density doesn't change much in density throughout the timber but rimu can. Even though they are all softwoods they are not all soft because "softwood" is only a name for a tree type. Some parts of the wood are harder or softer depending on whether they are from the heart of the tree or from the outside or from younger trees. Heart rimu is usually hard and OB rimu is much softer. Softer wood can shrink more than more dense wood so we have to think about that when we build with it. Pine is very permeable, which means it soaks up liquids easily. But my recycled timber is heart wood so it's denser and not as permeable. That may affect how I put finishing coats on them. Also the denser timbers make much finer dust when sanding and cutting and so does the MDF. MDF also has formaldehyde resins in it which are toxic. Pine and rimu also have knots from where branches were but MDF doesn't.

Softer woods are easier to work with but can damage easily. I had to consider the grain direction in all of the parts of my project and sometimes this affected what techniques I used. Because MDF has no grain it is better in some places because it won't split along the grain like pine. MDF does have layers and these can be like weetbix and split apart. It also is very permeable so it can soak up liquids and if it soak up water it will swell up. I also had to consider the thickness of the wood I used as this can affect how I worked with it or glued it. This is called the cross section and as boards get wider they should get thicker or will twist or warp more. Some of my components had routed profiles on them and this sometimes affected which techniques I used and how I carried them out.

Resistant materials are hard unlike textiles which are soft. So resistant materials can do damage to us when we cut or shape them.

Teflon doesn't dissolve in water so if small Teflon dust particles get into your lungs they can stay there a long time and create scars and it got on to their cigarettes and burnt and they inhaled the smoke. So when we use Teflon we always wash our hands afterwards. Also Teflon is a man made resistant material. It is safe mostly except if you burn it or raise the temperature too high. Then it becomes very hard and can cause eye injury and I wear earmuffs all the time to prevent getting hearing damage from the loud noise.

I followed all of the safety rules in the workshop: I wore covered shoes all the time in case something sharp fell from a bench: I kept my hair tied back and my shirt tucked in to prevent them getting snagged in a rotating machines: I know there is a safety RCD device on all of the power points in the workshop to prevent electric shock in case I accidently cut a cord: I always walk only in the workshop and I never talk to someone when they are using a machine. I make sure I put my safety goggles on when I use rotating machinery to prevent eye injury and I wear earmuffs all the time to prevent getting hearing damage from the loud noise.

Safety

The Health and Safety in Employment Act means we are all responsible for keeping safe and following the safety rules. We have to eliminate, isolate, or minimise hazards in our work. People who don't can be prosecuted if an accident happens. When we choose a resistant material like MDF we must identify why it is dangerous and whether we can eliminate isolate or minimise the risks. We get the information from Material Safety Data Sheets. MDF dust has more fine particles so is more explosive than larger particles like pine dust so we need to have the dust extractor on where we cut and sand, and avoid any flames. That's why we have a separate metal work room. We are not allowed to blow down work areas with compressed air as this fills the room up with a hazardous dust.

All dust can be dangerous so dust extractors were turned on whenever I was cutting or sanding. Pine dust has larger particles because it is less dense than rimu or kauri or MDF. Even though pine is not a dangerous dust, rimu and MDF dust are believed to be a cancer causing so I had to take extra precautions when I was working with those. Rimu dust and MDF dust have very fine particles and these are the most dangerous.

Marking out

Marking out on Pine is different to that of Rimu or MDF. While I use the same measuring tools, a tape, a square and a steel ruler, I found that pine was easy to indent with the pencil and leave a clear mark whereas Rimu and MDF it stayed on the surface. I had to be careful what marks I put on the pine as it was hard to sand them out. I used a marking knife across the grain for pine and for Rimu to prevent chipping but the MDF was much too hard, and because it doesn't have grain I didn't have to worry about it chipping. While the pine and the rimu both had one side better than the other, the MDF was exactly the same on both sides, so I didn’t have to choose. I marked the face side of the timbers with the “∥” face mark.

We cannot use an ink or marker on pine, rimu or MDF as it would soak into the porous material and leave very deep marks which would prevent using clear or stain finishes. All marks have to be removed for those finishes. If it was a non porous material like a metal it would not affect the finish so much.

The pinus radiata had some knots so I was careful to make sure these ended up away from where I had to cut or machine. I didn’t have to worry about that with the MDF as it doesn’t have defects or grain. When you have a knot near the edge it can fall out or chip. Knots are also very dense so the blades and drills can go a little crooked if you are half on a knot and half on normal wood. Knots are very hard to plane as well. This also means that you get more waste from knotty timber than from MDF and I had to allow for that when I was marking out. I was able to mark out the drawer parts from any direction on the sheet of 16mm MDF because it doesn't have grain and I
got better use of the material. Whereas the pine I had to make sure the grain was running vertically up the sides of the cabinet and sideways across the top. I also had to mark out considering the matching of grain in each piece as I didn’t want different densities when I came to putting on finish coats and showing different colours. And because it was 140mm wide I had to join three together to get the width I needed. Using narrower pieces helps to prevent the finished pieces from warping or cupping. I used a gauge and a bevel to mark out the dovetails on the drawer sides but had to go over the gauge line with an encil because it wasn’t easy to see on the MDF because it has such a hard surface.

**Cutting**

MDF, pine and rimu can all be cut on the band saw but changes in the density of some pine and rimu means the blade can wander as you cut. Sometimes the blade will follow a soft grain pattern and it is more difficult to be very accurate. To avoid that we can set up a guide fence and keep the wood against it as we cut. This doesn’t happen with MDF as it has no grain.

Pine and rimu often have tension in the wood that is released when we cut it. This can jam blades or change the dimensions of our work. MDF is stable and doesn’t change during cutting.

I set up a router with a 5mm router bit to cut a groove for the drawer bottom. I checked it wasn’t plugged in when I did that. Because MDF has very hard resins I used a carbide tipped router bit. I would use the same bit for rimu but I could use a high speed steel bit for pine. I set up a guide which will run a parallel groove because the MDF is so straight from the bench saw. I had to set the groove 7mm from the edge of the MDF. If it was pine it could be closer but MDF breaks away because of the layered fibres. I also did another groove for the drawer runners to slide on. These were 8mm deep. I made sure I wore a dust mask as formaldehyde resins can harm our lungs. I wouldn’t wear one using pine but I would with rimu dust as that can cause cancer.

I cut 3 dovetails on both sides of my MDF drawer using a tenon saw and a bevel edge chisel. I used a mallet and the chisel to pare any excess down to the line. The MDF is easy to pare across the layers but you have to be careful not to break away the back fibre layers when the chisel comes out the other side.

To cut the female dovetails I traced each set and cut down with a tenon saw. To chisel them out I had to clamp them to the bench and chisel down half way, turn over and chisel from the other side. Otherwise it would have split away the layers. When chiselling pine or rimu you have to cut across the grain first then chisel out along the grain. MDF tends to flake as you chisel down.

To cut the Teflon drawer runners I used the band saw and sanded down the edges. Even though Teflon is hard it still cuts very easily on normal tools. It feels like cutting cheese.

For the trim around three sides of the cabinet top I had to first use the router to profile a length of rimu, then I used a mitre saw to cut the mitres. The splintery grain and the delicate shape of the profile on the rimu meant that I had to always mitre from the face side and only put downwards pressure on the forward stroke. If I did that drawing back it chips away the delicate shape of the wood right on the end and makes it untidy. Ordinary square shapes are not as fragile.

**Joining**

Gluing techniques

MDF has layered fibres which are compressed very hard but can flake away like weetbix. The glue soaks in very quickly to the ends because the fibres are open. Pine also soaks in quickly to the end grain, because it has a loose grain, but the heart rimu I used had very tight grain, so the ends weren’t as porous. This means for gluing that I had to put more glue on where the MDF joined to the end as it soaked in very quickly which moves the glue away from the two surfaces. This is important as I wanted enough glue for strength but not so much that it squirted everywhere and left ugly glue stains. Harder woods can be joined with thinner glue, which is less viscous.

Mechanical fixing techniques

The layers in a compressed sheet board like MDF just split apart when we try to put a nail or screw into the end. Also nails and screws do not hold as well into the end of MDF as they do into grain of pine or rimu. But screws from the face side of MDF are very strong as they grab across the layers. A hinge screwed across grain of pine will be strong but not into the edge of MDF. But a hinge screwed into the face of MDF will be as strong as or stronger than into pine.

Nails into MDF just make a hole in the fibres and the nail can slide back out, where as in pine and rimu the fibres are pushed apart and they spring back jamming the nail.

For nailing I used thinner pan pins of 25mm x 1.2mm when I pinned the MDF dovetails together. The nails are really just to keep pressure on the glue and force it to penetrate into the wood. For nailing the softer pine I didn’t have to worry about splitting, but with the heart rimu I even had to use a small pilot hole especially if the nail was near the edge.

Because of the permeability of pine, the equilibrium moisture content can change and the wood can shrink or expand. Usually it shrinks as we live in warm dry houses. The top of a cabinet should be fixed down from underneath with screws that have an oversized clearance hole to allow for shrinkage. That stops it distorting the cabinet. Recycled rimu is less likely to do as it is older, denser and more stable. MDF is called dimensionally stable so it won’t shrink, but it may warp if it gets too dry or damp on one side or the other.

**Finishing**

Timber has grain that has to be considered when we are sanding. Dressing grade untreated pine has marks on the surface, and other construction marks that have to be sanded out. MDF comes with a very smooth face so the face is best just fine sanded. To sand the face of MDF will be as strong as or stronger than into pine.

Mechanical fixing techniques

When it came to sanding the cabinet top, I had to sand the whole top first, and then go back along the grain of the rimu edging the different hardness’s made it easy to dig too deep into the pine. I used the orbital finishing sander because it has small rings and you can’t see them across the grain lines.

The grain in pine can change density which changes the permeability so stains and other finishing coats can show different colours on the same piece of wood. As well the permeability of pine and rimu means the stain dries very quickly and makes it hard to keep a wet edge. For pine and rimu you have to be careful to keep the edge of the stain wet across the whole piece being stained and not let it dry. This would coat on some parts. Grain lines mean that you put the stain on with a cloth in long strokes so the lines match the grain.

We don’t do that with MDF, as it has no grain. Also on the end grain where the end of the fibres shows they are very absorbent. A special thicker mix of stain slows the absorption, or you can use a gelatin that is already more viscous. Or you can put on a conditioner to partly seal the end grain. Finishing techniques for metals are usually solid colours and there is no grain to worry about. To prevent pine and rimu from warping a sealer coat has to be put on the inside surfaces too.
Grade Boundary: High Merit

2. For Merit, the student needs to demonstrate in-depth understanding of basic concepts used to make products from resistant materials.

This involves:

- explaining how the characteristics of resistant materials influence safe technique selection
- explaining which combinations of techniques and resistant materials would be suitable for use in a situation.

The student explains material characteristics of a range of timbers, and appropriate measures to minimise safety risks when working with the material to make a kitchen work table (1). The explanation includes reasoning for why particular techniques were selected and what may or may not happen as a result of the selection.

The student explains combinations of materials and techniques (such as marking out pine and rimu) which are suitable for the kitchen work table. Links to characteristics of the material are made (2).

To meet the requirements of Excellence, the student needs to present discussions. For example, this might include comparing and contrasting with other techniques that may have been used or the characteristics of other materials that may differently impact on technique selection.
Characteristics
My project is a kitchen work table with butchers block top and is made from untreated Pinus Radiata (pine), which was merchant grade (merch) and recycled OB rimu for the table frame, and rough sawn walnut and recycled rough sawn heart rimu for the butchers block as the top. The table legs are laminated and turned on the lathe. The pine is very soft because of its low density and has a very light colour which is the same across the wood, some loose knots and even straight grain. The walnut is very dense and hard. It has swirly grain patterns and the knots are very tight. The OB rimu is about the same density as pine but a different colour which is why I chose it to laminate with pine for the turned legs. For the wedged mortise and tenon joins I used rimu wedges for their contrasting colour. The recycled heart rimu is also dense and very hard, it has a tight squeezed up grain but it's straight, it has no knots, but it has lots of variation in its colour. The butchers block will be made with the end grain facing up.

Pine is soft as a wood because it is not as dense as the harder woods like rimu or walnut. Density is the weight per cubic metre and pine is below 400 kg/m3 whereas walnut is more than 550 kg/m3. Heart rimu is also around 600 kg/m3. The different density affects what tools we use to machine it, how dangerous the dust is, and how we join to it and put finishing coats onto it. I chose pine for the table frame because I had to make several mortise and tenon joins and wood with a straight grain allowed me to do that.

The butchers block top has the end grain facing upwards which is unusual in most furniture and meant that I couldn’t machine it the same as normal. How much liquid will soak into a wood depends on how dense it is and how tightly packed the grain is. It also depends on whether or not you are putting the liquid onto the face or the end grain. Even the changing grain in one bit of wood can change how we cut it or what techniques we use to put protective coats or finishing coats on.

Safety
Students at school are called “others” in the Health and Safety in Employment Act. That means the school has to make sure we are safe when we work and also that we work safely. We are also training for working in industry later so we have to start acting like employees. That means we have to work safely all the time, try to reduce the risks in our work, and be mindful of the other people around us when we work.

In my project I had some resistant materials that created dangerous dust when I cut or sanded them. The dense wood heart rimu is called carcinogenic because it has resins in it and very fine particles that can float around in the air and get into our lungs and cause cancer. Walnut is also dense so makes very fine particles. The way we avoid the dust is by turning the dust extractor on when we cut or sand and do it near an extraction gate. We go outside when we use the finishing orbital sander so the dust can blow away.

Variations in grain creates hard and softer patches that can make cutting blades or drill bits wander off and this can be dangerous so we clamp down our work or run it against a fence to keep it straight. We should always secure work for the router anyway. I wanted to put the butchers block I had laminated through the thicknesser but was not allowed. This is because the grain was vertical up and down and the knives would have just shattered the wood and spat big chunks back out. We can only put along the grain work through the thicknesser. Chips or splinters of wood are sharp and fly around when cutting so we have safety goggles on whenever we cut or drill. Very hard woods can burn if our tools are not sharp so we always use carbide tipped blades for rimu and for walnut. We also use them for pine but we could just use high speed steel.

Because resistant materials require powerful and sharp tools we have to wear covered shoes to protect our feet, tuck in shirts and tie back hair to avoid getting caught up, walk carefully so as not to bump anyone, wait for people to finish using a machine before we talk to them, have safety goggles on near machines and earmuffs ready all the time.
Marking out
I found I could mark out all of my materials with a pencil ruler and square. The surfaces are soft enough to write on. I did find it difficult to mark on the end grain so I used a ballpoint pen. Marks are hard to get off pine so I was careful to mark softly on the pine. I also used a marking knife for the cuts I would make across the grain as this gives the wood fibres a place to chip off which is straight. It’s also easy to know when you’ve cut half the line off like the teacher says.

I was careful to avoid knots on my cutting lines or where I had a piece to rebate as the knots are very hard and dense and in pine the loose knots come out when cutting. The merch pine was very knotty. I did not want to hit a knot when I was turning on the lathe. Also you can’t nail through knots, and because the knotty wood is less porous the glue doesn’t soak in as much. The recycled heart rimu didn’t have knots but was very hard, and I tried to keep the very hard walnut around the walnut wood knots because I wanted the hardest wood for the cutting board. For turning I marked out the high and low points on my table legs and used the callipers to check the dimensions as I went.

Cutting
I cut all of the pine and OB rimu on the band saw, which is easy because they are soft and then used a sharp plane to shave accurately down to the lines. I had to chisel a sloping mortise through the table legs and a tenon onto the rails between the legs. I cut a saw cut into the tenons for a wedge which is hammered into the tenon from the other side when it’s assembled. The way the grain splits apart means that the wedge can expand the tenon and lock it in place. You couldn’t do this across the grain. I drilled through the centre of the mortise first then was able to chisel away the rest. I had to start chiselling from where the shoulder of the tenon was as I was chiselling slightly across the grain for the angle of the wedged tenon. Otherwise I would be going into the end grain and that would make it split. To cut to the shoulder on the tenon I cut across the grain with the tenon saw and again chiselled the rest which split away easily along grain.

After I had laminated the pine and OB rimu for the turned legs I had to plane the corners off with a hand plane. Because timber splits along the grain, when you are turning a square shape on the lathe the tool can split off big chunks. This is dangerous and wasteful. By planing it down first you can limit the amount that can split off. When you are turning you can tell you are shearing the fibres if you get long thin shavings. If you get chunks you are breaking the grain and the wood will be rough. I also had to cut downhill towards the centre so I didn’t dig into the grain. Sanding on the lathe is difficult as the wood is very soft and spinning fast and it’s easy to make everything round. I wanted to keep the sharp profiles on my legs so I had to get the best finish straight off the tool that I could. Once I had turned the shapes I had exposed some new end grain which will let the timber dry unevenly so I put a timber sealer coat on while it was on the lathe.

Finishing
Because rimu and walnut dust can be very bad for us I made sure I wore a mask when I was fine sanding. I couldn’t put the end grain block through the thicknesser so I had to sand the whole top to an even surface. I used a 60 grit belt on the sander to make it even, then I made a wide hand sanding block wrapped with 80grit, then 100, 150, and lastly 240. I did the finishing with the orbital sander outside to blow away the dust. The tight grained wood stops germs from getting in but the wood needs a protective coat as it will soak up liquids. I couldn’t use a toxic oil so I chose walnut oil which doesn’t go rancid like vegetable oil.

I used Danish oil as a finishing coat on the table. It made the colours stand out in the timbers, and highlighted the wedges and the end grain in the tenons. If the tenons were hidden you wouldn’t see the wood colours.
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<td>The student gives some explanation of combinations of techniques and materials to make a cabinet, more so for joining and finishing (2) (3).</td>
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<td>To meet the requirements of Merit more securely, the student needs to show more links between characteristics and safe handling and use. Also, the explanation should show more combinations of techniques that relate to the characteristics of the materials involved.</td>
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My project is a cabinet with a panelled door and is made from Untreated Pinus Radiata (untreated pine). I chose untreated pine because I have experience in working with it and because it is a safe material to use. Untreated pine does not have any chemicals added to it when it is processed so I don’t have to wear any protective clothing or a special dust mask that you need when you use treated timber. Pinus radiata has a low density of around 450kgs per cubic metre compared to more than 600 kgs per cubic metre for Rimu. This means it has characteristics that we have to think about when we are working with it. It is soft so we have to be careful not to damage it when we move it around the workshop. Even objects on the bench can make deep marks that are hard to get out. It soaks up liquid very easily which can help when we put coatings on it. It has loose fibres in the grain so it can easily break away when cutting but also that makes it easy to chisel. The light colour of pinus radiata means we can choose more colours of stain and finish coating. It means we can match native timbers, or we can just leave it clear finished.

Working with Pinus Radiata in my project

Safety

The Health and Safety in Employment Act is a law that makes sure people are safe when they are working. In our workshop we have to wear covered shoes all the time in case we drop a sharp object on our foot. We tuck in our shirt and tie up any loose clothing or hair, because we use many machines that rotate and can catch loose items. If that happened we could be dragged into the machine and injured. There are safety goggles we must wear whenever we use any rotating machines and we wear earmuffs almost all the time. Hearing damage happens whenever we are exposed to loud noises and we don’t notice it happening. The HSE act makes sure we take responsibility for our own safety and minimise risks whenever we can. One of the reasons for choosing untreated pine is that it is less toxic than treated timbers, Medium Density Fibreboard and native timbers like rimu. Another reason is that it produces larger particles when we cut and sand it as they fall to the floor instead of floating in the air for us to breathe.

Marking out

Untreated Pinus radiata is an easy material to mark out because it is light coloured and is soft. But it usually has a good side and a bad side from the machining so I tried to work on the face side. I also checked for any loose knots that may make it hard to cut. I used a pencil and steel ruler for most of my marking out, but had to use a marking out knife for the marks that go across the grain. I did this so that when I cut across the grain the wood fibres didn’t chip past the knife line. I had difficulty marking out the corner mitres for the cabinet door because the rails and stiles were profiled. I had to mark out the long and short points and this has to be very accurate as a tiny mistake on a mitre means it will not fit together without gaps. Also when gluing the mitres have to be able to press up tight to put pressure on the glue. I used a gauge to mark out the rebate for the bottom shelf and also for the top rails that are used to fix down the top. Because the wood is soft it leaves a deep scratch that is easy to follow with tools and also prevents chipping past the line.

Cutting

I cut most of my cuts using the band saw which has a steel blade. I always wore safety goggles in case a piece of wood flung off the blade which can happen if you hit a loose knot when cutting. I put the blade guard down to about 10mm above my work. This is so there is less chance of accidently touching the blade, and also means the blade is less likely to twist when it passes through different hardness’s in one piece of timber. Very hard materials like rimu or MDF can blunt a blade and this makes the blade unsafe. Keeping our hands on both sides of the blade means if the blade hits a soft part of the pine our hands don’t slip into the blade.

Even though untreated pine is not toxic I still made sure I had the dust extractor on as this keeps the dust out of the workshop and keeps the others safe as well. Dust is bad for our lungs and can also explode. Pine dust has larger particles so is a safe choice for cutting and sanding.

I had to use a small hand plane to trim off the wood down to the line. This is easy along the pine grain as it peels. But when I was going across grain I had to place another piece of wood as an end stop to prevent the wood splitting off the end. I used a router to cut a groove for the bottom shelf. I had to make sure my wood was cramped onto the bench so it couldn’t move and cause and accident, or wreck my work. I used a guide timber against the left. Both hands have to be on the router so you
can’t accidently injure yourself, and because the router is spinning and spitting out chips of wood I wore safety goggles, and earmuffs for the noise. I cramped another piece of wood on the far side and let the router run into it so the grain wouldn’t split away when the cutter exits. The router bit had a carbide tipped cutter as once high speed steel loses its edge it can get very hot and burn the wood. The skirting around the base of the cabinet was cut from a length of decorative profiled timber. The profile made cutting the corner mitres more difficult as they chipped easily. The grain in pine is loose which means the ends can break away when you cut them on a mitre saw. To avoid this I cut using the manual mitre saw and cut long slow strokes with a very fine toothed blade. I used a small G cramp to hold the wood still and stop it getting dragged into the cut.

Joining

To widen the top sides and shelves of my cabinet I decided to dowel join the pieces together. Wide thin boards can cup because the grain is uneven across the board due to growth rings in the tree. So it is better to use narrower boards of about 150mm and join them together. The dowels have grain running along their length so they use the long ways strength when they go across a join. Using dowel joins also helps to keep the top surfaces flush so it makes sanding and finishing easier. I marked out the centres of the dowels using a ruler for length and a gauge for the width. The gauge also leaves a groove that helps keep the drill bit aligned. I set up the parallel borer with a brad point drill bit and the depth to allow for excess glue. The brad point bit has a very sharp centre and an edge cutter. I used this because it runs true even if there is a wobbly grain in the wood. Normal twist drills can go crooked in pine where there are hard and soft grain patches and that makes it harder to line up the dowels. I cramped the work piece still while I drilled and kept my hands clear of the line of the drill bit. I also made sure I had my safety goggles on.

To cramp up the boards I had to lay all my work out on the sash cramps first. I used PVA glue as this penetrates deep into the porous pine when you put pressure on. Using PVA means you have to put medium pressure on to force the glue into the wood. But I had to protect the soft edges from the steel cramps with blocks of wood, as they can dig in. I laid another sash cramp across the top to stop the boards bowing up under pressure. I had to wipe off extra glue with a wet rag to prevent the glue from staining the wood. Pinus radiata soaks up the glue very quickly and any stains will stop finishing coats from penetrating. This looks untidy at the end.

Finishing

Sanding dust can be very dangerous for our lungs so I made sure I sanded near the dust extractor to avoid filling the workshop up with dust. I also never use compressed air to clean down benches as OSH say we should not do that as it blows fine dust into our lungs. I used a belt sander with 100 grit paper to sand the faces of all of my pieces before I assembled them. I had to be careful to move the sander in long circles to avoid cutting grooves into the soft pine timber. I never sanded any end grain with the belt sander as it can change the shape of the wood and the way it fits together. I did the rest of the sanding once I had assembled my cabinet, using 150 and then 240 grit sandpaper, using a sanding block to keep the sandpaper flat.

The Pinus Radiata is not very dense and has a loose grain that makes it soak up liquids very quickly and can go deep into the wood. I decided to stain my cabinet but I found that the stain colour soaked in very quickly to the end grain and as a result the colour was much darker than the rest. I had to put an extra coat on the faces to match the darker end grain bits. I put the stain on with a cloth rolled into a pad as a brush leaves brush marks which can hid the attractive grain. I had to make sure I kept a wet edge so I didn’t get more than one coat on at a time or this also changed the colour of the finish. The stain made the grain stand up so I sanded it with 400 grit wet and dry and then wiped the surface with a cloth to remove the dust before I put on a clear finish coat of polyurethane. The first coat I thinned down with about 10 percent mineral turpentine to allow it to get right into the porous wood. I used polyurethane to make the surface harder as pine is very soft. I made sure I put one coat on the underside of all of the pieces of work too to stop the pine soaking up moisture from the air and warping or twisting. The polyurethane also made the stain look rich in colour.
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<th>Grade Boundary: High Achieved</th>
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4. For Achieved, the student needs to demonstrate understanding of basic concepts used to make products from resistant materials.

This involves:

- describing characteristics of resistant materials
- explaining safe techniques to be used with resistant materials
- describing which combinations of techniques and resistant materials would be suitable for use in a situation.

The student describes characteristics that affect how pinus radiata is worked when making a cabinet (1). They explain safety and its role in their work as related to particular tasks (2). The student also explains why some cutting, joining and finishing techniques are suitable for different materials or why they are carried out as they are (3) (4).

To meet the requirements of Merit, the student would need to give the reasoning behind the choice of suitable techniques. Combinations of techniques for the material should be explained in more depth.
My project is a cabinet with a panelled door and is made from Untreated Pinus Radiata (untreated pine). I chose untreated pine because I have experience in working with it and because it is a safe material to use. Untreated pine does not have any chemicals added to it when it is processed so I don’t have to wear any protective clothing or a special dust mask that you need when you use treated timber. Pinus radiata has a low density of around 450kgs per cubic metre compared to more than 600 kgs per cubic metre for Rimu. This means it has characteristics that we have to think about when we are working with it. It is soft so we have to be careful not to damage it when we move it around the workshop. Even objects on the bench can make deep marks that are hard to get out. It soaks up liquid very easily which can help when we put coatings on it. It has loose fibres in the grain so it can easily break away when cutting but also that makes it easy to chisel. The light colour of pinus radiata means we can choose more colours of stain and finish coating. It means we can match native timbers, or we can just leave it clear finished.

Working with Pinus Radiata in my project

Safety

The Health and Safety in Employment Act is a law that makes sure people are safe when they are working. In our workshop we have to wear covered shoes all the time in case we drop a sharp object on our foot. We tuck in our shirt and tie up any loose clothing or hair, because we use many machines that rotate and can catch loose items. If that happened we could be dragged into the machine and injured. There are safety goggles we must wear whenever we use any rotating machines and we wear earmuffs almost all the time. Hearing damage happens whenever we are exposed to loud noises and we don’t notice it happening. The HSE act makes sure we take responsibility for our own safety and minimise risks whenever we can. One of the reasons for choosing untreated pine is that it is less toxic than treated timbers, Medium Density Fibreboard and native timbers like rimu. Another reason is that it produces larger particles when we cut and sand it as they fall to the floor instead of floating in the air for us to breathe.

Marking out

Untreated Pinus radiata is an easy material to mark out because it is light coloured and is soft. But it usually has a good side and a bad side from the machining so I tried to work on the face side. I also checked for any loose knots that may make it hard to cut. I used a pencil and steel ruler for most of my marking out, but had to use a marking out knife for the marks that go across the grain. I did this so that when I cut across the grain the wood fibres didn’t chip past the knife line. I had difficulty marking out the corner mitres for the cabinet door because the rails and stiles were profiled. I had to mark out the long and short points and this has to be very accurate as a tiny mistake on a mitre means it will not fit together without gaps. Also when gluing the mitres have to be able to press up tight to put pressure on the glue. I used a gauge to mark out the rebate for the bottom shelf and also for the top rails that are used to fix down the top shelf. Because the wood is soft it leaves a deep scratch that is easy to follow with tools and also prevents chipping past the line.

Cutting

I cut most of my cuts using the band saw which has a steel blade. I always wore safety goggles in case a piece of wood flung off the blade which can happen if you hit a loose knot when cutting. I put the blade guard down to about 10mm above my work. This is so there is less chance of accidently touching the blade, and also means the blade is less likely to twist when it passes through different hardness’s in one piece of timber. Very hard materials like rimu or MDF can blunt a blade and this makes the blade unsafe. Keeping our hands on both sides of the blade means if the blade hits a soft part of the pine our hands don’t slip into the blade.

Even though untreated pine is not toxic I still made sure I had the dust extractor on as this keeps the dust out of the workshop and keeps the others safe as well. Dust is bad for our lungs and can also explode. Pine dust has larger particles so is a safe choice for cutting and sanding.

I had to use a small hand plane to trim off the wood down to the line. This is easy along the pine grain as it peels. But when I was going across grain I had to place another piece of wood as an end stop to prevent the wood splitting off the end. I used a router to cut a groove for the bottom shelf. I had to make sure my wood was cramped onto the bench so it couldn’t move and cause an accident, or wreck my work. I used a guide timber against the left. Both hands have to be on the router so you can’t accidently injure yourself, and because the router is spinning and spitting out chips of wood I wore safety goggles, and earmuffs for the noise. I cramped another piece of wood on the far side and
let the router run into it so the grain wouldn’t split away when the cutter exits. The router bit had a carbide tipped cutter as once high speed steel loses its edge it can get very hot and burn the wood. The skirting around the base of the cabinet was cut from a length of decorative profiled timber. The profile made cutting the corner mitres more difficult as they chipped easily. The grain in pine is loose which means the ends can break away when you cut them on a mitre saw. To avoid this I cut using the manual mitre saw and cut long slow strokes with a very fine toothed blade. I used a small G clamp to hold the wood still and stop it getting dragged into the cut.

**Joining**

To widen the top sides and shelves of my cabinet I decided to dowel join the pieces together. Wide thin boards can cup because the grain is uneven across the board due to growth rings in the tree. So it is better to use narrower boards of about 150mm and join them together. The dowels have grain running along their length so they use the long ways strength when they go across a join. Using dowel joins also helps to keep the top surfaces flush so it makes sanding and finishing easier. I marked out the centres of the dowels using a ruler for length and a gauge for the width. The gauge also leaves a groove that helps keep the drill bit aligned. I set up the parallel borer with a brad point drill bit and the depth to allow for excess glue. The brad point bit has a very sharp centre and an edge cutter. I used this because it runs true even if there is a wobbly grain in the wood. Normal twist drills can go crooked in pine where there are hard and soft grain patches and that makes it harder to line up the dowels. I cramped the work piece still while I drilled and kept my hands clear of the line of the drill bit. I also made sure I had my safety goggles on.

To cramp up the boards I had to lay all my work out on the sash cramps first. I used PVA glue as this penetrates deep into the porous pine when you put pressure on. Using PVA means you have to put medium pressure on to force the glue into the wood. But I had to protect the soft edges from the steel cramps with blocks of wood, as they can dig in. I laid another sash cramp across the top to stop the boards bowing up under pressure. I had to wipe off extra glue with a wet rag to prevent the glue from staining the wood. *Pinus radiata* soaks up the glue very quickly and any stains will stop finishing coats from penetrating. This looks untidy at the end.

**Finishing**

Sanding dust can be very dangerous for our lungs so I made sure I sanded near the dust extractor to avoid filling the workshop up with dust. I also never use compressed air to clean down benches as OSH say we should not do that as it blows fine dust into our lungs. I used a belt sander with 100 grit paper to sand the faces of all of my pieces before I assembled them. I had to be careful to move the sander in long circles to avoid cutting grooves into the soft pine timber. I never sanded any end grain with the belt sander as it can change the shape of the wood and the way it fits together. I did the rest of the sanding once I had assembled my cabinet, using 150 and then 240 grit sandpaper, using a sanding block to keep the sandpaper flat.

The *Pinus Radiata* is not very dense and has a loose grain that makes it soak up liquids very quickly and can go deep into the wood. I decided to stain my cabinet but I found that the stain colour soaked in very quickly to the end grain and as a result the colour was much darker than the rest. I had to put an extra coat on the faces to match the darker end grain bits. I put the stain on with a cloth rolled into a pad as a brush leaves brush marks which can hid the attractive grain. I had to make sure I kept a wet edge so I didn’t get more than one coat on at a time or this also changed the colour of the finish. The stain made the grain stand up so I sanded it with 400 grit wet and dry and then wiped the surface with a cloth to remove the dust before I put on a clear finish coat of polyurethane. The first coat I thinned down with about 10 percent mineral turpentine to allow it to get right into the porous wood. I used polyurethane to make the surface harder as pine is very soft. I made sure I put one coat on the underside of all of the pieces of work too to stop the pine soaking up moisture from the air and warping or twisting. The polyurethane also made the stain look rich in colour.
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My project is a cabinet with one drawer and a door and is made from untreated pine. I decided on untreated pine because it is quite safe to use and also because it is easy to work with. It does not have any chemicals added to it which means it is non-toxic when you touch it or cut it. The real name for this wood is Pinus Radiata. It has a low density which means it is soft and also that the grain is not squeezed up tight. Grain is what we call the fibres in the wood and they affect how we work with it. Pinus Radiata is also porous which means it will soak up liquids easily.

**Working with Pinus Radiata in my project**

**Safety**
Before I started my work I made sure I had followed the safety precautions in the workshop. I had covered shoes on in case I drop a sharp tool, my shirt was tucked in to avoid getting caught in rotating machinery, and I had my safety goggles and earmuffs ready. The workshop is noisy and we can slowly damage our hearing by not wearing muffs even though we can’t tell it is happening. It is important in the workshop to take responsibility for our own safety as this is what is expected when we go and work later on.

**Marking out**
I used a pencil and a steel ruler with millimetres to mark out the sides, the shelves and the rails of my cabinet. I used a square to make sure the 90 degree angles were accurate. For the cuts that were going across the grain I made another line with a marking out knife. Because Pinus Radiata has a loose grain it sometimes chips when you cut across the grain. By using the knife it gives the grain a line to chip on and leaves a tidier edge. When I marked out the hinges for the door I used a butt gauge which also has a sharp edge that leaves a shallow cut in the wood. Because Pinus Radiata is soft the butt gauge cuts a line deep enough to fit the end of a chisel when you chisel out the hinge.

**Cutting**
Cutting Pinus Radiata is quite easy using normal steel blades because it is soft. I used the band saw to cut along and across the grain and then I used a hand plane to trim down to my line. I made sure that I had safety goggles on in case a chip came flying off the wood and hit my face, and that the band saw blade guard was set down close to the wood. Doing this means there is less blade showing that could accidently cut your hands. It also means that the blade bends less when you are cutting. I made sure I never put my hands in front of the blade as many accidents on the band saw are people pushing their hands into the blade. I also made sure the dust extractor gate was open for the band saw. By sucking away the dust there is less moving around the workshop. When I was planing across the grain I put a piece of wood on the far end to stop the plane from splitting the last grain from the wood. Whenever I use hand tools I keep my hands behind the blade to avoid cutting my hands. If your hands are behind the blade you can’t accidently push the blade or cutter onto yourself.

**Joining**
I had to make the wood wider for the top, sides and shelves of my cabinet so I used the biscuit jointer and number 20 biscuits. Wood is stronger along the grain as it has tensile strength, so biscuits have the grain going diagonally across them to get the most strength across a join. I set the biscuit jointer to the middle of the 20mm Pinus Radiata and set the depth stop to allow extra space for excess glue to go. I evenly spaced using a ruler and then cut the grooves for the number 20 biscuits making sure I had both hands on the jointer; this way if the machine kicks back my hands are safely on the machine. I also used an F cramp to hold the wood still. This is necessary to avoid the wood moving and creating a situation for an accident to happen. I got all the sash cramps ready before I started gluing and laid all of the pieces on the cramps. I applied PVA glue to one edge and to all of the biscuit grooves and then tightened the sash cramps up. I protected the edge from the cramp with a block of wood on each one. To stop the pieces from bowing upwards I laid another sash cramp across the top and tightened it.

**Finishing**
I found Pinus Radiata to be easy to sand but because it was so soft the rough 100 grit sand paper left deep cuts. I had to sand these out with a finer grit of 150 and then remove those scratches with 240 grit wet and dry. I was careful not to sand across the grain. The hardest part was sanding the end grain of the Pinus Radiata. When I had planed the end grain the plane had ripped out some of the wood so there were rough holes all along. I used a sanding block to make sure I was sanding flat.
made sure to do the sanding near the dust extractor as any dust is not good for our lungs. I also avoided using compressed air to blow the dust around as this is unacceptable in industry. The Pinus Radiata is very loose grained and this makes it absorbent. To make sure my finishing coats of polyurethane got into the wood I thinned down the first coat with about one part of mineral turpentine to 10 parts of polyurethane. I brushed the first coat on and put it on quite thickly then cleaned up my brush with turpentine. The next day I sanded the surfaces with 400 grit wet and dry sandpaper to remove the roughness and brushed on another coat with out any thinning. I did the same again a day later but was careful on the last coat to wipe the brush very gently along the grain to lay off the polyurethane and try not to show any brush marks. I also made sure that there were no runs or puddles of polyurethane that would spoil the look of the surface. I did this with careful brushing.
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6. For Achieved, the student needs to demonstrate understanding of basic concepts used to make products from resistant materials.

This involves:

- describing characteristics of resistant materials
- explaining safe techniques to be used with resistant materials
- describing which combinations of techniques and resistant materials would be suitable for use in a situation.

The student describes some characteristics of tanalised pinus radiate, which they use to make an outdoor table (1). The student describes safety as it is carried out (2).

To meet the requirements for Achieved, knowledge of the influence of characteristics as they relate to how the material is worked must be demonstrated. The student should describe more of those characteristics and link these to techniques carried out (3).

While they do describe safety precautions, they must also explain why they have taken these important safety precautions. This may be in the form of what may happen without precautions, or definitions of the hazards that make safety important.
**Characteristics of materials**

My project is an outdoor side table made from tanalised Pinus Radiata. I decided to use this timber because it will last longer in the weather. The tanalising is a chemical that prevents rot from growing in the wood and is made of copper sulphate, potassium dichromate and arsenic pentoxide. Tanalised Pinus Radiata is quite soft so is easy to cut but splits easily. I made sure there were no knots as these look unattractive. It is important to select wood that will be suitable for the people who are going to use the product. For this table the user wants an attractive table with no knots.

**Working with Tanalised Pinus Radiata in my project**

**Safety**

When I started I made sure I had followed the safety precautions in the workshop. I had shoes on, my shirt was tucked in and I had my safety goggles and earmuffs ready. I also had a dust mask just in case I needed it.

**Marking out**

I marked out my project parts using a steel ruler and a square. I used a gauge to mark out the parallel assembling lines where the parts joined but only where the lines were not seen as the gauge leaves a scratch in the wood. I used a marking knife to mark across the grain as I didn’t want the ends to chip when I cut them.

**Cutting**

Cutting Tanalised Pinus Radiata can be done with steel cutters and blades. I made sure the dust extractor was on for the band saw and cut to within a millimetre of the line with the band saw, then planed down to the line using a small jack plane. I wore safety goggles and set the blade guard low. When I planed the end grain I used a ‘stop’ at the far end to prevent splitting off. I kept my hands behind the blade like I do with all hand tools.

**Joining**

Because my table is outside I had to make sure that the top was weather resistant. This meant I had to use waterproof PVA glue. Waterproof PVA has chemically bonded resins that resist the way water breaks them down so perform much better in wet conditions. If I use good glues the table will be more durable and the people using the product will be satisfied.

To join the pieces on the top I decided to use a tongue and groove. Having a join right along the length of the top will make the top much stronger and weather resistant. I routed a 4mm groove in both sides using a router with a guide and used a plywood lath as the joining piece. I had to sand the edges of the lath to let it slide into the groove. I also made sure that the three ply had two of the grains ply’s going across the join for added strength.

For safety I held the router with two hands and cramped my work piece to the workbench.

**Finishing**

I sanded my table top and the sides and legs with the belt sander and a 100 grit belt first going along the grain. This makes sure I get no scratches across the grain which are hard to remove later. Using a sanding block and 150 grit sandpaper and then 240 grit sandpaper I brought the surfaces to a fine finish ready for finish coating.

I had to apply a protective finish coat to my table. After researching products I settled on an exterior polyurethane. This will make the table resistant to weathering and water. I applied the stain with a brush after reading the instructions and made sure that I put more on the end grain. This will stop water from getting into the end grain. After the first coat and 12 hours drying time, I sanded with 400 grit wet and dry sandpaper and applied another coat. After another 12 hours I sanded again with 400 grit paper and brushed on the final coat, making sure to avoid ugly runs as people don’t like a messy finish.