WORKSHOP NOTES

TWIGLING

ABOUT BALLJOINTED DOLLS

The use of ball joints in dolls is to simulate simplified human movement and poseability; however articulation comes at the cost of aesthetic, a doll that is more articulated will look less realistic and more mechanical, while a doll with little articulation will look more realistic, but with a more limited range of movement and expression, which may defeat the purpose of having joints in the first place. It's up the individual artist to find a balance between the two, in accordance with the purpose of the doll.

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VISIBILE BALL-JOINTS

Joints and the transition between parts, as well as the slots that allow flexion of the joints, are a normal part of a balljointed dolls anatomy and serve as a reminder that these are dolls and not people. The joints have an inherent beauty all of their own and there should be no need to hide them completely, although it might be desirable to blend them in with the parts of the doll so they do not stand out too much. Or rather, that the joints should look equally apparent or obscured whether they are static or flexed. Those who are not used to seeing joints on their dolls may be distracted at first, but when they discover the possibilities that open up, they often find that the joints blend into the background and are not as noticeable.

Obvious joints in the overall appearance of a doll makes no attempt to hide the transition between parts, instead they celebrate poseability; this type of doll could easily be displayed naked as a piece of art to fully show its sculptural detail and jointing.

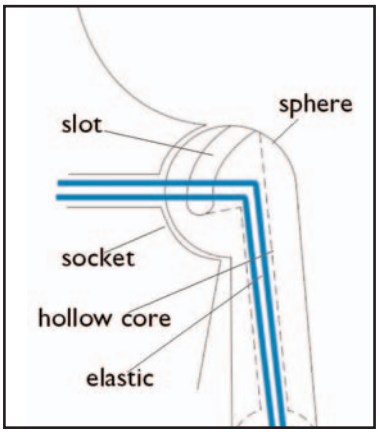
Photo by Britta K. Bergersen

If you try to hide the joints when they are extended, remember that they will be visible when you flex the joints, so think about why you are hiding them in the first place, since the point of the joints being there is for the doll to be able to be posed.

BALLS, SOCKETS & SLOTS

There are five different elements that work together to create a moveable ball joint; a sphere, a socket, a slot, a cavity or stringing channel (hollow core) and elastic tensioning.

The slot will dictate how far and in what direction a joint can bend. A joint will not want to defy the limitations of a tight elastic or the end of a stringing slot unless significant pressure is put on it, and then once pressure is removed the joint will snap back to its natural position.



Slots are most often of a uniform width, but can be shaped as an elongated figure-eight to help lock the elastic into certain angles. Or they can have a wider opening at both ends of the slot, again to help hold the elastic and thus the joint and limb in a certain position. A narrow slot will grip the elastic constantly and help with incremental posing.

A shallower socket will allow more movement than a deeper socket; and the more of the sphere of a balljoint that sticks out, the more movement you are able to get out of it. The length of a slot must allow not only for the movement of the elastic but also for the thickness of the elastic itself.

There are a multitude of ways to apply balljointed motion to any given point of articulation, and as well as this the balls can be fixed or floating, single or double, they don't necessarily need to be round at all! Even the sockets can be floating in the form of a separate part. You can put the socket where the ball would normally be and vice versa, play with the size of the spheres, the depth of the sockets, the balljoint can be large and obvious or smaller, flattened or merged with the bodypart so it no longer stands out as a ball.

If you want, you can even omit some joints if you feel it is more important that the area looks attractive than be poseable, look for example at non-jointed torsos and fixed ankles; in addition most dolls do not have jointed fingers, although there are a lot of joints in the hand. Most artists choose instead to create more than one pair of hands for a doll if they want to be able to vary the expression and function in that part.

STRINGING, TENSION & FRICTION

The elastic is a bit like the muscles of the doll, in that it holds the doll together and allows it to pose. Balljointed dolls are strung with anything from one to three lengths of elastic. The elastic used should be the round type which consists of multiple rubber filaments inside a woven fabric tube. Elastic comes in a variety of thicknesses and qualities. The more filaments inside the fabric sleeve the stronger and harder the elastic will be. A length of elastic is measured out and doubled over, the ends are then tied together in a secure knot. The most common method of stringing is two lengths of elastic; one shorter goes from hand to hand via the arms, shoulders and upper torso, and the other length goes from foot to foot via the legs, torso, neck and head. The arm-elastic is measured from elbow to elbow across the shoulders, doubled and then you add another 4 inches for the knot. The torso/leg elastic is measured from the top of the neck via the length of the body and to the knees, doubled and doubled again, and 4 inches is added for the knot.

The tension of the elastic can be loose for a floppy doll that drapes across the surface you put it on. A loosely strung doll feels more pliable and cuddly, but may have trouble standing up or holding a pose. A tightly strung doll is rigid and sturdy and will be easier to pose, although if there is little friction in the sockets the doll may have a tendency to 'kick' or snap its joints suddenly. The elastic will go whichever way is shorter and will tend to want to be as straight and contracted as possible. It is also important that all the stringing holes line up with each other, as if they don't the elastic will move the offending joints to find the path of least resistance. Elastic also does not like to bend more than 90 degrees per angle, which is why we stack the angles in double joints to get more movement. If one part of a double joint bends more than 90 degrees and the other bends less than 90 degrees the elastic will want to balance them so that they are both even at 90 degrees (or less), and the double-joint piece will skew and not sit properly in its sockets.

Dolls such as the Sybarites and the SD16 girls have two elastics, but the longest one isn't bent in half at the neck s-hook like usual, well one end does, the other goes into one leg and across the hips into the other leg. The new Unon/Unoa Zero goes one step further and have three separate elastics, one goes through the arms, one goes from the neck via the upper torso into the lower torso and the third goes from foot to foot across the hips, so that there are no stringing slots at the front of the hip joints.

By adding surface friction in the sockets, the balljoint will have something to grab onto and this way even a relatively loosely strung doll will be able to hold a pose, also you'll be able to move the joints incrementally instead of the joint preferring to stay only in the straight and fully flexed positions. Socket friction can be added by gluing in thin pieces of leather, called pliver; or by coating the sockets with a thin layer of hot-melt glue from a glue gun. Hot-glue sueding is a quick and dirty method which is reversible and needs to be redone relatively often. Pliver sueding is more time consuming to do, but also more durable if the right glue is used. The use of pliver is a throwback to antique porcelain dolls where leather was glued between the joints to prevent the sound of porcelain surfaces rubbing together. The pliver used to suede a balljointed doll is thin and flexible, but a quite fragile. The flexibility means that it can be stretched and shaped to fit into a socket without needing to cut it into a specific shape.

RESEARCH, EXPERIMENTATION & INSPIRATION

I believe that the best way to understand ball jointed dolls is by playing with them, testing out the capabilities of their joints by posing them and trying to get them to sit, stand, balance and pose in different ways. Some artists incorporate little gimmicks that are meant to improve the articulation or appearance in one way or another, and if they are successful you'll soon see them copied or imitated by other companies. The humble balljoint is in many cases giving way to oval-joints, cut-joints, double-joints, pull-out joints as well as locking mechanisms to help hold a pose, cut-away's where a chunk of solid resin has been removed to help a limb bend further (where the soft tissue of a human would compress to allow movement).

By looking at pictures of doll joints you can get an understanding of how they work, and the way jointing is solved

is usually different from one manufacturer to the next, but in the end there are only so many ways to cut and bend a knee, so there is bound to be some inadvertent copying between various dolls. I think that in the beginning it is probably easiest to look at and imitate the jointing of existing dolls, and most probably it won't be noticeable because your sculpt; the face and the body is unique to your design, and that is what a potential buyer or client is going to look at first.

Personally I have an open-source view on articulation, I feel that the concepts should not be copyrighted but that an artist should be allowed to use a same or similar type of joint as another in their creation. You would use what you like and omit the rest, borrowing the knees from one doll and the elbows and ankles from another. Chances are that by the time you have imitated the look and function of a joint it probably doesn't look the same anymore, and underway you will have found that by changing a little here and there, the joint works and looks a little better than before. And this way we get an evolution of articulation so that dolls gradually become more posable, or perhaps just posable in a different way. The artist would thus be able to shop around and borrow ideas from a multitude of different dolls, taking what they feel is the best solution from several different places and apply to their own product. Hence each artist does not have to invent and engineer a revolutionary new jointing system for each new doll they create, but can draw from a library of ideas and instead concentrate their creative juices on the look and shape of the actual doll.

Although, I should clarify that when I say it it okay to be inspired by the jointing of other dolls, I do not mean that you can modify the actual parts of another artists work and present the resulting product as your own, but rather that you study it and try to sculpt your own while being inspired by their ideas. Direct copying is a big no-no, but it does not apply if the work you are copying is originally sculpted by yourself.

THE MAKING OF TWIGLIMBS

Being somewhat underwhelmed by the range of motion in BJDs at the time (late 2005), I started making plans to sculpt a set of more articulated arms and legs for a junk SD10 torso I had bought on Yahoo!Japan, and researched how the articulation was engineered in existing ball jointed dolls. I had a doll head that I liked (DollsTown Estella) but I couldn't find a BJD body that was big enough to look in proportion to this head, I wanted to make the doll look mature (but not busty) and proportioned. Keep in mind this was before the time of Dollmore Models and SD16 Oliva Morgan etc. I was inspired by Gentaro Araki's Unoss with her wide hips, thick legs and big feet because I felt that regular SD/60cm dolls feet were too dainty... perhaps not fashion-doll dainty, but pretty small nonetheless. Another thing I wanted was to have better than average posability, so I wanted to make double joints. I think I was fairly intent on finding my own solutions to how these joints should work, but of course there were some ideas that were too good not to borrow, and I was heavily inspired by Serendipity's Mini 14 girl "Ismy", which had pull-out elbows and hips and a knee-joint with extended flexibility.

I did start out with a plan on paper, but drew everything too big, and ended up going more on instinct and comparing with other doll parts that I had on hand. I also made a lot of rough sketches for how the joints might work, but as I started building I found that what worked on paper didn't necessarily translate well to 3D and there were constantly angles and aspects I hadn't considered. This meant that I had to rebuild and modify quite often as almost every time I tried out an idea there was something I hadn't thought of that got in the way of some part of that joint working properly. Also because I was working on the one set of parts and making modifications to it instead of making new parts all the time, I had no previous saves to go back to if I had done something wrong. In addition, every time I did a test stringing, the thin parts and details took damage and wear that had to be repaired over and over again and caused several delays. It also made me loose motivation and become despondent, so at times the best thing to do was simply to walk away and do something else while my subconscious continued to mull the problems over till I was ready to have another go.

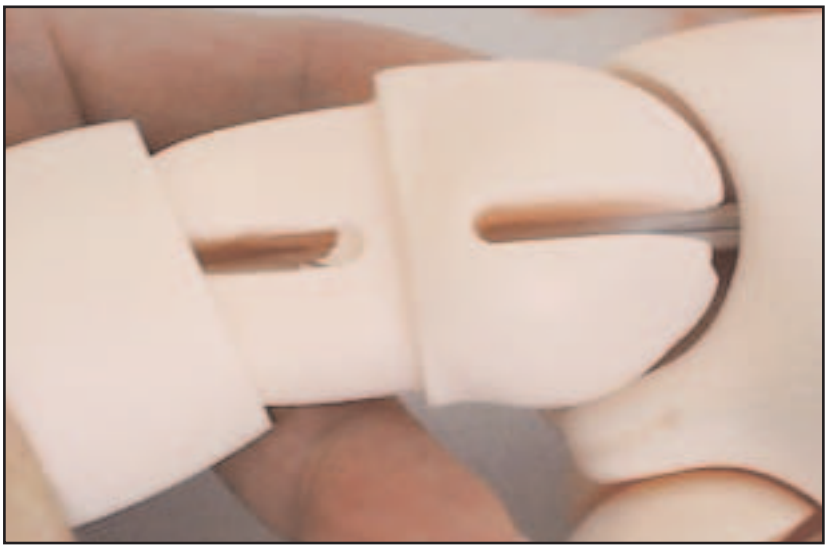
I have found a few different online and printed tutorials for making ball-jointed dolls ~ but while I have been inspired by them, my process hasn't happened in the same way at all points. In some cases I was simply experimenting with more available methods and materials.

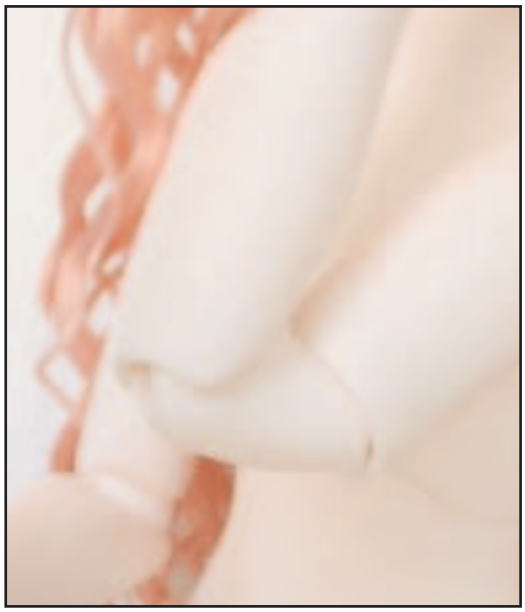
Then of course there is the language barrier, all the books and websites I have come across are either in Japanese or Korean and I don't read or speak either of those, so for a large part I have been relying on pictures, and while they can be very descriptive I may very well have missed a few important points.

When I first started I was very concerned about making the balls for the balljoints completely round, and I could not conceive of a way to do this purely by hand; so using various household items like bottle lids, marbles, fishing sinkers, wooden beads and even the handle of a nicely shaped toothbrush. I made push molds from plaster or even apoxie sculpt and used cling wrap as a barrier to stop the clay from sticking to the molds. For some reason I had the idea that the balljoints needed to be hollow, so I made them in halves that I glued together and then drilled slots and stringing channels into.

I would determine what sizes to make the balljoints by looking at the size of the finished doll and comparing to other dolls in that range. The final girth of the parts in that area would also have some importance in deciding the diameter of the balljoints.

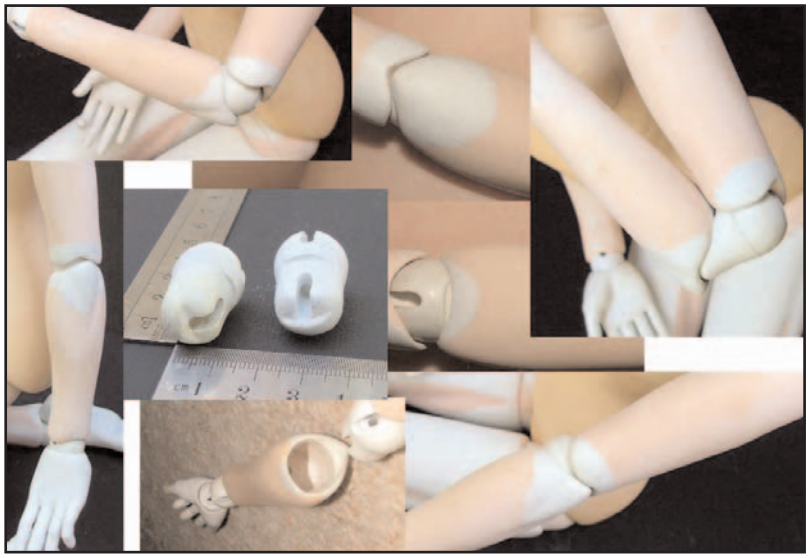
Photos borrowed from Milkshake Melody (Unoss/SD), Vicki Jones (Serendipity Ismy elbow and hip) and SerendiptityDoll.com





Later I realised that trying to make the balls completely round was a lot of extra work, and I started rolling them freehand in my palms. If they needed to be hollow I would use a small styrofoam bead at the core. When the ball was relatively round I would set it aside to harden and make another one roughly the same size (balljoints usually come in pairs). When the clay was hard, I would sand and file the balls to refine the shape. I find this is the easiest way to work with apoxie, by sculpting roughly and then refining when the clay is hard; sculpting in stages and adding a bit at a time so as not to damage one side while working on the other.

I started with the arms and used lengths of electrical conduit as a core which I sculpted over with Apoxie sculpt. I also cut and beveled the end openings to shape. The first elbow joint I sculpted looked exquisite when posed in hyperflexion, and appeared as a single joint when the double joint was not in use. But I suppose I didn't test the joint properly with elastic stringing, or I didn't think it through enough, and in actual fact the joint didn't work properly because the point that formed the elbow when fully bent and hooked over the edge of the lower arm obstructed the elastic when the extension was hidden inside the lower arm. I was forced to revise the mechanics, and ended up with an elbow where the secondary joint was still hidden inside the lower arm, but instead of having a catch that hooks on the outside of the lower arm, there is now a small ledge near the top of the opening where the elbow part rests when you pull it out. And the elbow point itself is now a part of the lower arm instead of a part of the double joint.



I have since observed the many and varied ways that artists have approached double jointed elbows, and I can say with certainty that yes my solution was unique, but part of the reason for this would have to be that it's not necessarily a very good solution. The shoulders and wrists are pretty standard affairs and work well enough, but the elbow is in some ways a failure, or rather it is an early ancestor of what I hope with evolution will become something better, or it might be a dead end.

The legs were made in one piece with clay over a fabric tube filled with beach sand. They were sculpted in many layers side by side, trying to make left and right as similar as possible. I left the both ends open, and while I knew that I wanted to make the kneejoint a double one, and that I wanted an angled cut similar to that of the Unoss, I did not know how I wanted the joint to work. I tried several different approaches, but I was mostly taking inspiration from pictures of other dolls without having handled those dolls in person and this meant that I didn't have a complete understanding of what I was looking at.

I ended up with something that looked oval from the front and like an apostrophe from the side. The primary flexion was spherical while the secondary was hidden inside the lower end of the thigh and would pull out and rest on a shelf inside the sculpted kneecap. I also hollowed out the back of the thigh so the leg was able to bend further without the oval of the knee part needing to be very long which would not only look bad but work poorly with incremental bending of the primary flexion of the knee.

I found that the lower part of the knee in my case didn't need to be completely round so I shaved a bit off the back which made the line of the leg a lot smoother. During sculpting the knee seemed to work well, but when I did test stringing I could not get the secondary flexion to sit properly on its little internal shelf. I resolved to add pips to the joint and grooves to the socket to force the joint to sit where I wanted it to. As a result the joint lost its smooth oval appearance when exposed, but now functioned as it was supposed to. I have since made an improved knee joint for the next doll, which I believe will work better without compromising on looks. It will also be easier to pose.

I had wanted a double jointed hip as well, so the doll could curl up in a foetal position, although this was made difficult by the very sway back of the non-jointed torso I had started building the Limbs for. The old SD body was also known for being ungainly and hard to pose, but to be fair it was one of the first BJD bodies out there. Its hip joints were

small and placed far to the front of the body, and the original legs had spherical balljoints that stuck out a long way at the front. I started with spherical hips, but flattened the front so it would not stick out as much, the joint was also pill-shaped and fit into a socket at the top of the thighs. I didn't want to make any modifications to the torso, because I wanted to make the Limbs work for it so that others could benefit from the perceived improvements over the original SD without having to make changes to the body itself. So it became a question of trying to make due with what was there and compromise my ideas.

The hip joint was made in three parts; first I used clay to make an imprint of the hip sockets, so that the hips would fit, then I used the core of a toilet roll to make a cylinder and half a styrofoam sphere to make the bottom end. The three parts were covered in clay and joined together into one piece, and I used an off-cut of PVC pipe with the right inner diameter to make sure the cylinder was completely round. Then I added the slots and a small pip that would lock the secondary flexion into position and would limit the axial rotation inside the thigh to stop the leg from spinning back to front. I used the newly formed hips to build up the sockets at the tops of the thighs.

When it came to the bottom half of the hip joint I wanted it to sit neatly without any gaps when the joint was pulled out, so I didn't make a neat cut across the thigh, where the hipjoint would be much narrower at the bottom half, and instead let the thigh stick out a little bit but not so much that it would look obvious. The shape of the opening at the top of the thigh reflected the fact that the joint needed room to move in certain directions during hyperflexion, so it was lower at the front, and higher at the back where it followed the shape of the buttox. It was also higher at the outside where it helped to smooth the lines between the legs and the torso.

The double jointed hip also added an extra swivel joint, so that the legs could turn in or out when the hips were bent, which helped the doll cross its legs, sit in the lotus position and sit 'cute' with its knees together and the lower legs pointing outwards or backwards. Here I've had to make more compromises, the lack of articulation in the torso meant that the doll had some trouble sitting up, especially when sitting cute where the higher outer edge of the thigh butted against the front of the hipsocket where the doll had to lean back on its hands or against a wall to stop from falling backwards.

Because of the placement of the hipsocket the doll would not be able to sit with its buttox touching the surface, rather it would rest on the back of its thighs.

Over 18 months I sculpted and revised and altered and modified my parts several times, and all the while the BJD hobby was expanding with more and more companies releasing new dolls and designing new jointing. This way I was still researching new styles while I was building and also learning from my mistakes.

The project grew from a set of auxiliary limbs for an older type of doll with unwieldy articulation and poor posability, to a full body when another artist contacted me and offered his own hand-made wooden torso for me to add to the set. I was given carte blanche with regards to making modifications to the sculpt which was a patchwork of putties and fillers over a soft-wood core. One benefit was that it was jointed — Ken Stone told me that he had used a large light bulb to create the roundness at the top of the lower torso, but that the bulb (which was quite expensive) broke in the process.

The only thing I didn't have was a head; the idea was that people could get more articulated bodies for floating heads they already owned. I added a little bit of sculptural definition to Ken's torso, clavicles, a bellybutton, hipbones, venus dimples and scapula. I also made a separate internal torso piece that could make the torso bend further backwards and forwards without limiting the regular range of motion.

I didn't make any changes to the legs and hips to be able to work with the torso, rather I tried to make some simple changes to the torso to make it work with the legs. Had I not made the legs for another specific torso to begin with, the hips would probably work and look much nicer. I did make the shoulder sphere smaller and added a shim so the arms would still work with the original SD10 torso, but I didn't want to add yet another part to the hip assembly which would likely destabilise it as well as make it look more mechanical.

After a year and a half I was more or less ready to start thinking about production, and looked for someone who could mold & cast my work. I found a guy (one state over, in QLD) in Australia that seemed promising, but halfway through

the project he backed out because he had not quoted properly for all the work that was involved with molding and casting over twenty parts of varying shapes and sizes, he wasn't making enough money from this little venture, and basically gave me the elbow in favour of some supposed large orders from the US Government. I got the molds that he had made so far, but didn't like the way they were set up, I also didn't feel I'd be able to use most of them the way they were.

At this point I had already sold preorders to about 25 people so I was quite heavily committed to filling the orders. I had based my prices on the quotes I got from the moldmaker and having already spent some of the money to get molds made and a handful of sets cast, I could not afford to refund my clients, and instead I decided to continue the work myself, because the materials were fairly cheap when compared to the cost of labour. I had been in contact with long-time doll artist Kaye Wiggs for the past year. Kaye had been casting her own dolls for a while, and she is completely self-taught; having spent the first 18 months after learning about balljointed dolls experimenting with resins and silicones trying to find the best materials for her dolls. Kaye offered to help me get started and so I ordered my materials and drove for 5 hours to get a crash course in moldmaking and casting. I had brought the molds from the other moldmaker but because of the way he had set up the molds they could not be used for pressure casting to get bubble-free casts. He also did not send me any moldboxes, which is what keeps the silicone molds stable while the resin is liquid. Kaye put me through some rigorous and character building sessions with smelly materials and some unfortunate weather patterns and by the end of the week I had a basic understanding of her mold-making methods as well as a new-found confidence in dealing with the casting process.

My partner and I had just bought a house and although we are not moving in till mid-December, I set up a casting workshop immediately after settlement so that I could start producing the dolls. For a time, casting became a fulltime job, and I would spend 10-12 hours in the workshop every weekday and pouring one or two dolls every day, so trust me when I say I was pretty sick of the sight of all the doll parts by the end of it. I was aching to focus on other projects which had been put on hold when I had to start doing my own production; and yet I had to put other things first. I had promised my parents I would come home to Norway for a somewhat overdue visit, and I went to stay with them for a month, taking with me a doll made from leftover parts to show them what I was making.

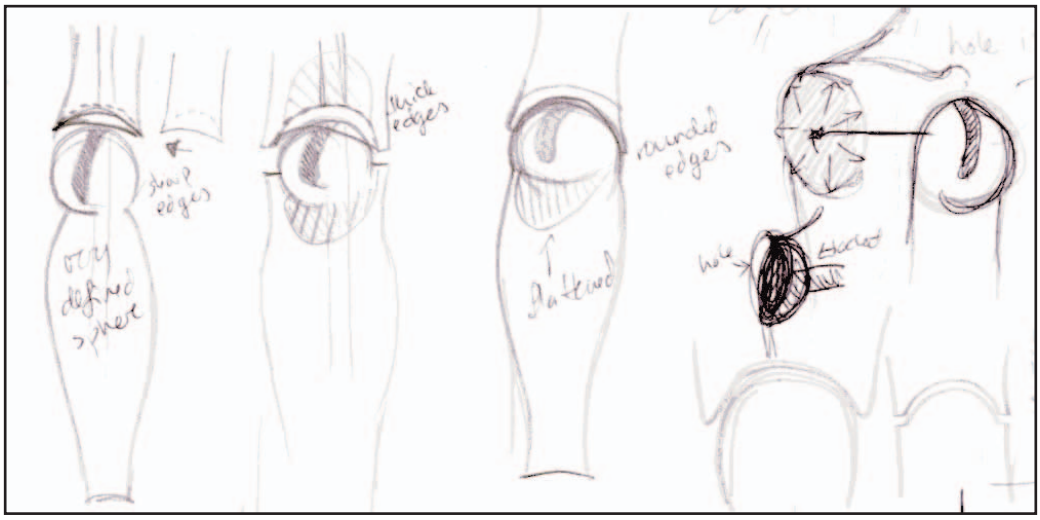
They were very impressed (though perhaps in that way that parents are always impressed by a child's drawing?) and carted me around to several locations where I could take pictures of the doll in a natural setting. My mother was interested to the point of talking about buying a doll for herself, and so I gifted her with the one I had brought with me. I also visited a Norwegian bjd enthusiast and photographer who took some really wonderful pictures of the twigLimbs body. Through skumring/Britta Bergersen's camera lens I was able to see the body in a different light, and fall in love with my work again. Britta was very excited about the prospect of having a more posable subject to take photos of and the possibilities this gave her as a photographer to create an expressive narrative through her pictures.

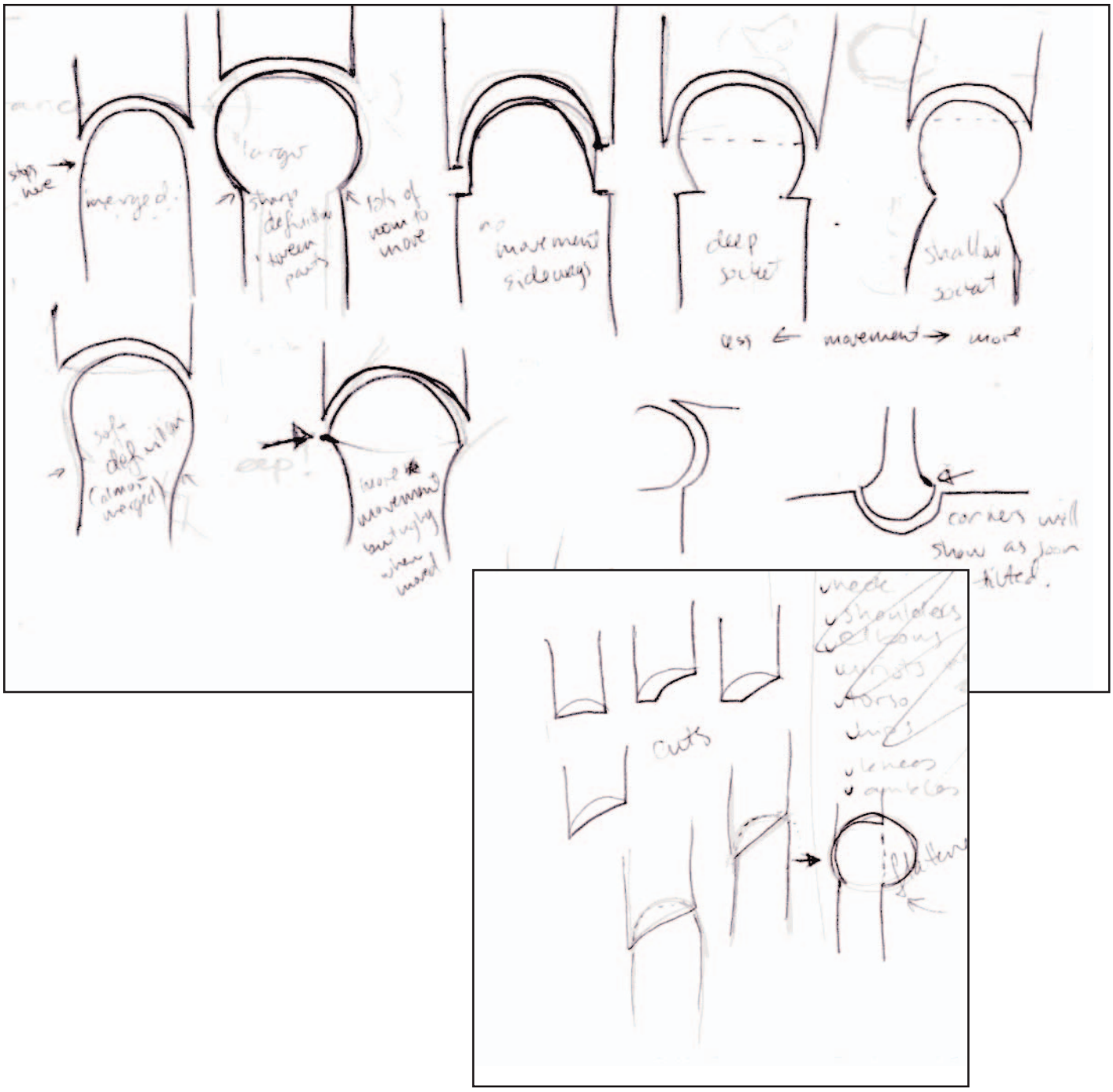
Even with all the work and revision I did on the first sculpt, I find I would still like to go back and rework the joints once more to make them work properly. I am quite happy with the look of the sculpt itself, but when I see the doll, the hips and to an extent the knees really bother me. I think I have a much better understanding of jointing now than when I started out, having looked at and handled more dolls since then, but also because I've had a chance to really manhandle my own product and figure out what is wrong; in addition I've also had a lot of feedback from the first buyers which has been very helpful.

Because of the way the twigLimbs project progressed, the end result is not what it might have been if I had started out with intent to make a full doll right from the word go. I also find that despite all the test stringing I did, there are several things that I hadn't considered which might indeed come across as rather severe flaws; such as the difficulty of working the pull-out joint mechanisms when the doll is fully clothed, given that even posing the doll while nude takes some getting used to.

The fiddly nature of the elbow and knee joints has in handling them has made me realise just how awkward they are; the movement of a joint should be a lot smoother than this, and shouldn't really require a lot of pulling to get the doll into a certain pose, or get it to stay that way till you move it or while arranging the other joints.

BALL-JOINTED ANATOMY





HEAD

Though not exactly what I would class as a joint, the head nonetheless consists of at least two components and is overall an important part of a doll. Differing from traditional porcelain dolls who have permanently glued pates and wigs, BJDs have easy access into the head so that eyes can be switched easily. Wigs or hair is also not glued on, but can be held in place with a fine-looped velcro, wide rubber bands, silicone caps or stickyback moleskin. Wigs often also have an elastic hem.

The most common division of the head is by a circular cut above the ears and behind the wigline at the forehead, making the lid a separate piece where the main (bottom) part of the head (including the face) connects to the neck. Another method was made popular by Gentaro Araki's Unoa dolls and involves a vertical division of the head, where the face and ears is a separate piece, and the back of the head extends down to connect with the neck. This allows easy removal of the faceplate without removing the wig or taking the head away from the body to switch the eyes.

Doll artists have tried many methods of attaching the parts of the head together, such as connecting the main S-hook that holds the elastic right through the body from the feet up to the head; snap-on headcaps, twist-on caps, sticky tape, press-studs, caps that slide on and lock in and the use of rare-earth magnets which are either glued in place or cast into the resin.

The horizontal-cut headcap usually has a lip or ledge on the inside as well as being a shape that will not allow it to

move or be put on back to front; while the vertical-cut faceplate mechanism has to be lifted and then pulled away from the rest of the head; or pulled away and then lifted.

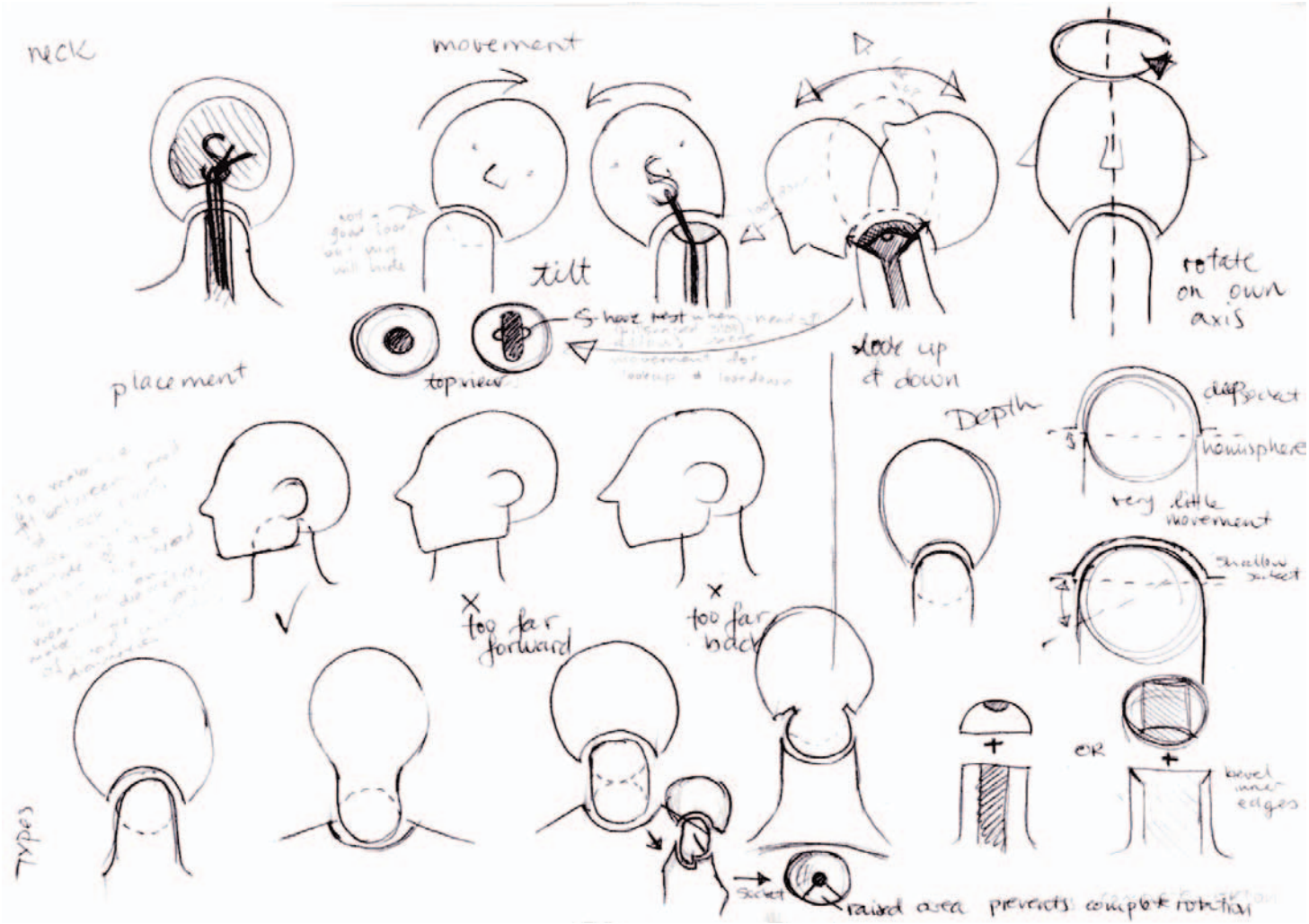
The head is made over a core which is later removed when the head is cut in half. For example a piece of styrofoam cut into a roughly cranial shape, a ball of scrunched up al-foil, a lump of plasticine, or a bladder filled with sand can be used as a core over which clay is laid to form the basis for a head. To stop the clay from sticking to the core-material, I recommend covering the core with cling wrap or putting it in a plastic bag before adding the clay; this will make removing the core a lot easier. When the clay is hardened and the facial features are blocked in, the head is cut open and the core removed. The two halves are then further reworked to fit together.

NECK

A joint placed in the neck should allow the doll to turn its head side to side, to look up and down, to cock its head and any combination of the above.

The neck is most often an extension of the upper torso and not a genuine part in itself, but where the neck and head meet is a point of articulation that allows for movement that can make a lot of difference in the expression of your doll. There is a socket at the bottom of the head which matches the convex or hemispherical top of the neck.

The neck can also be a separate piece between the head and torso. An additional joint in the neck does of course allow more movement, but the lower neck joint is highly visible as opposed to the upper joint which is hidden under the chin and hair. If there is detailing sculpted on the neck piece there is also a probability that the piece will be able to rotate on its own axis and the detailing could end up back to front. If you wanted to use this type of joint, perhaps making the



socket more shallow and the stem of the neck thicker, or by making the diameter of the balljoint larger than that of the neck itself you would get less of a gap and a smoother transition between the clavicles and the neck. You could also put a small 'stop' inside the socket that would prevent the neck from rotating further than it should.

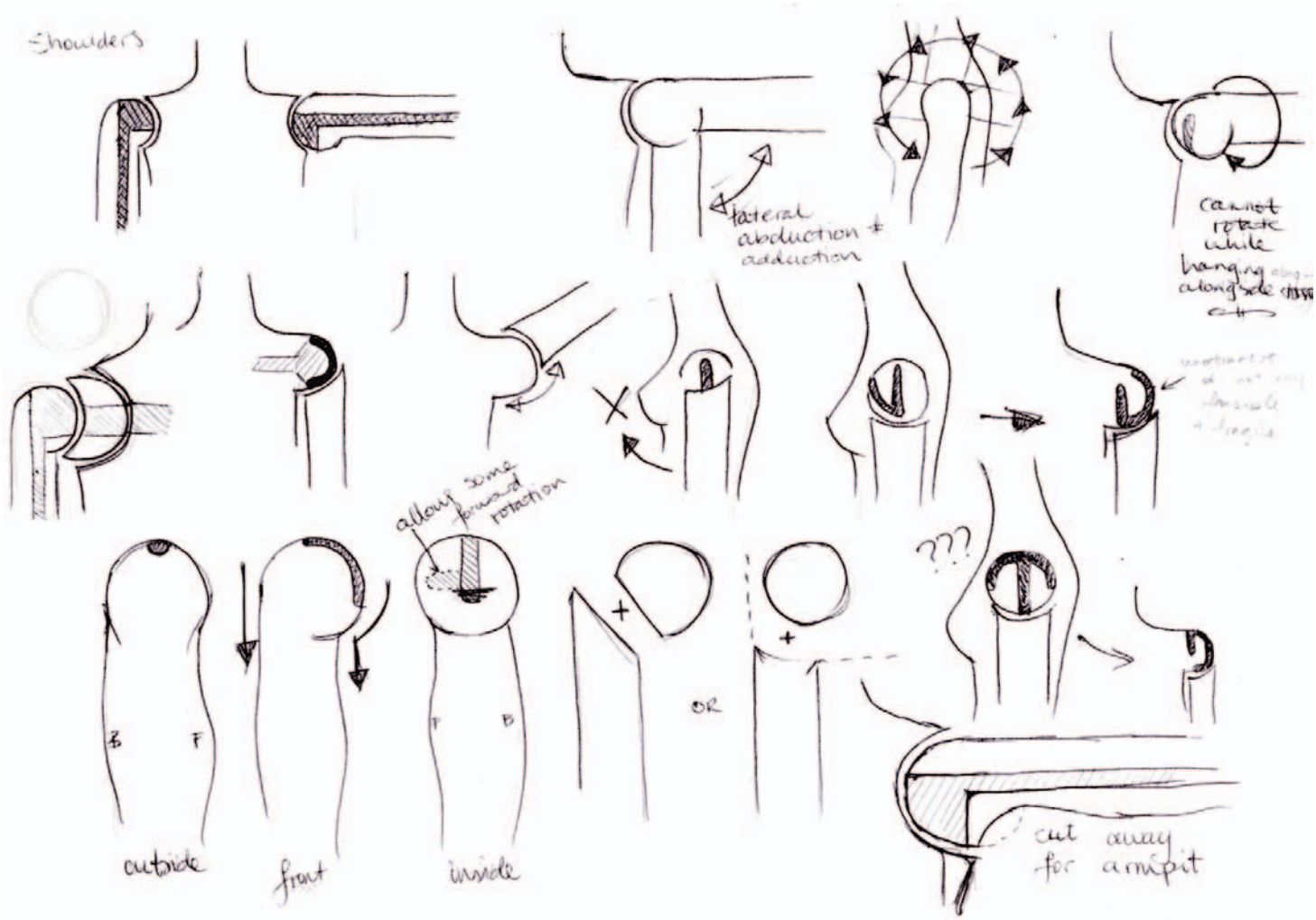
Porcelain dolls with shoulder plates, and also some art dolls have the lower neck joint instead of the upper. In this case the socket is at the top of the torso, and the hemisphere and neck extends from the bottom of the head. In the recently released Unon/Unoa Quluts Zero (Gentaro Araki) the neck extends from the torso, but at the top of the neck there is a socket, while the hemisphere or balljoint is attached to the bottom of the head.

Take care not to place the neck (opening) too far back under the head or too far forward, it should be roughly in the middle when you see the head from the side.

Shoulders

Shoulders should allow the arms to swing backwards and forwards, to stick horizontally out from the body, to be raised up above the head and of course to hang alongside the body. The shoulder will not let the arm rotate on its own axis while hanging along the sides of the body.

The shoulder balljoint is most commonly placed at the top of the upper arm, with the socket being at the outer edges of the upper torso. However the shoulder ball could also be a "floating" part between the torso and arm (though this would mean an extra gap or visible transition), or the ball could be attached to the shoulder with a partial socket in the upper arm, but this will limit the range of motion unless you get creative with the placement and shape of the stringing slot. The shoulder



is a pretty standard joint, and it should be easy to get it working and looking nice. When the arm is held straight out to the sides, the balljoint will be visible in the armpit where on a human there would be a depression. If you like, some of the sphere (below the slot) could be shaved away or blended into the upper arm.

First seen on the Cerberus Project Delf dolls was a separate cuff or shim between the ball and socket. This allows the shoulder to 'roll' forward, backward or upward for a subtle increase in range of movement, so that the doll can cross its arms over the front of the torso. This shim in itself is a partial balljoint which sits quite deep inside the shoulder socket, but on the other side it has another socket of its own where the balljoint at the top of the upper arm rests.

ELBOWS

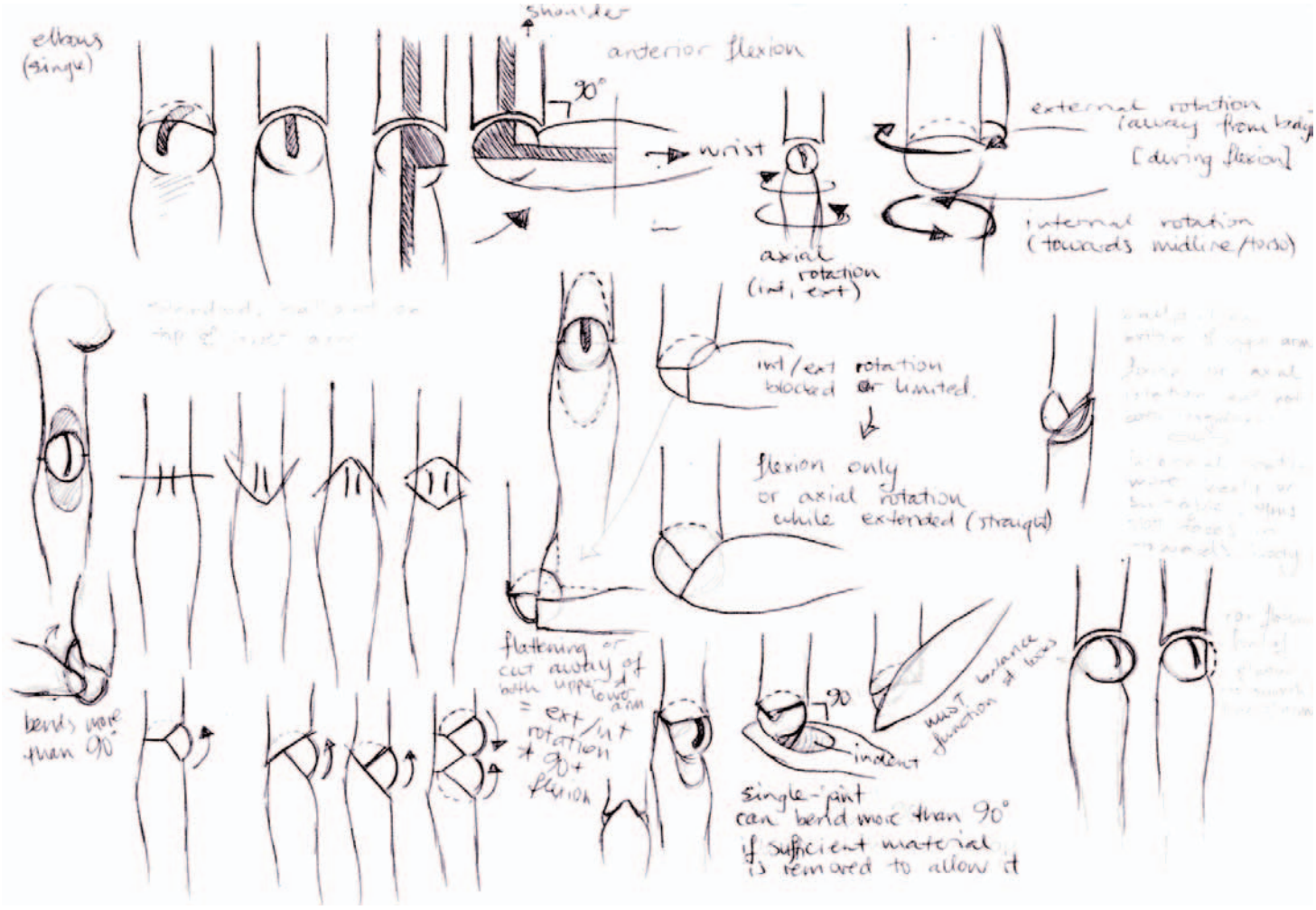
The elbow should be able to bend to ninety degrees or more forward, and to swivel out from the body or in towards the body. The balljoint can be placed at the bottom of the lower arm or at the top of the upper arm. It can also be a separate part, although this is more common where the elbow is double jointed.

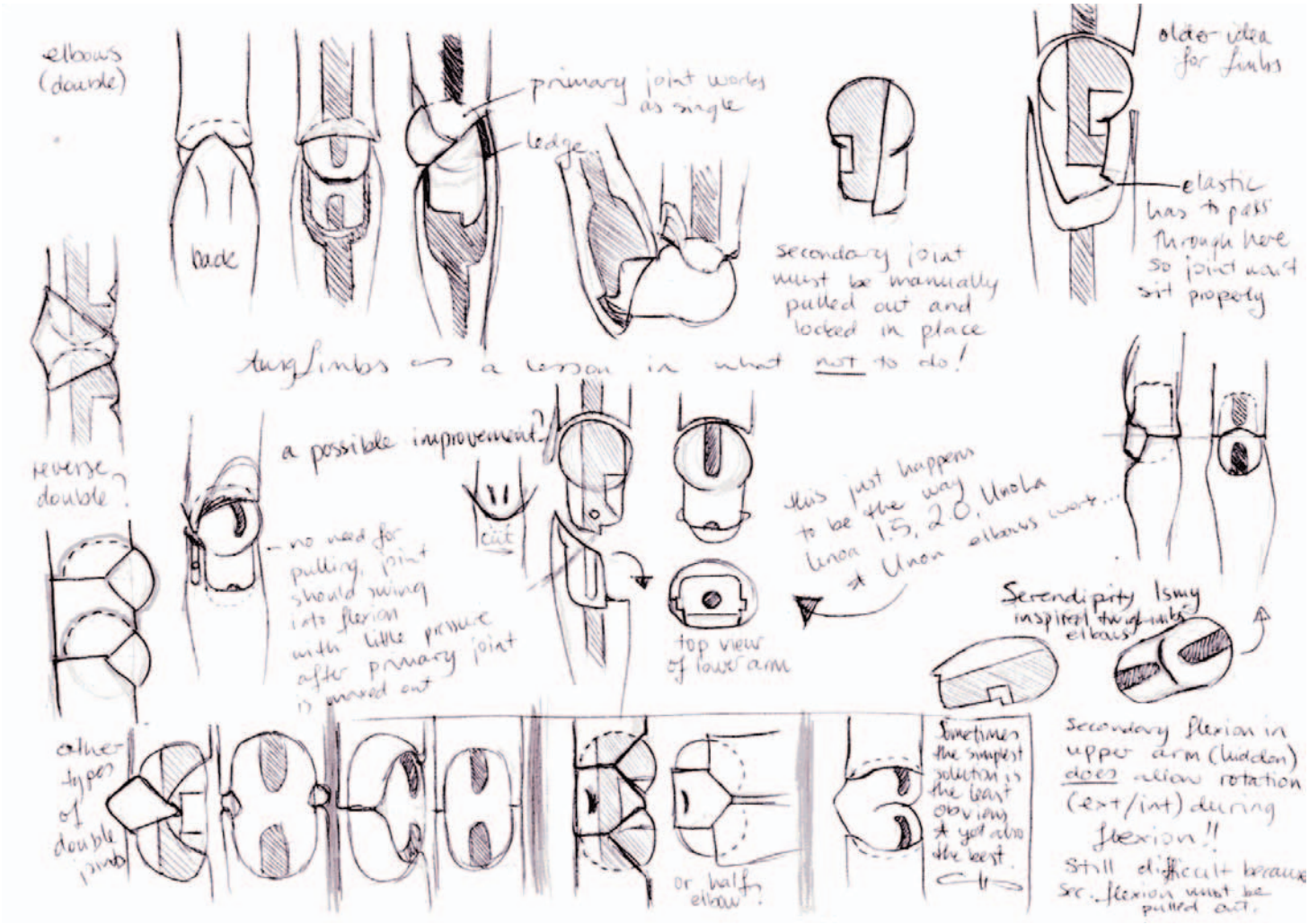
In most single-jointed dolls the balljoint is placed at the top of the lower arm; this way the single joint will allow the maximum amount of movement, in that it can swivel from side to side whether it is bent at the elbow or not. If the balljoint is placed at the bottom of the upper arm, the lower arm can swivel or rotate around the sphere when the arm is straight, but when it is bent you will not be able to use this motion to turn the arm out from or in towards the body, and you would perhaps rely on a shim in the shoulder to allow some of that movement, although you could also angle the slot on the sphere partially in towards the body rather than straight forward.

To smooth the line of the arm, the front of the elbow joint can be flattened if it sticks out past the arm itself.

An arm that is cut straight across where the elbow-joint will sit, will look good when the arm is straight, but when bent it may look jagged. The arm could also imply the elbow-bone in the cut in the shape of a V either extending from the upper or lower arm, which dovetails in with a corresponding slot on the opposite half of the arm when the elbow is extended. By flattening the girth of the arm near the elbow, but leaving the balljoint itself round, you can achieve a greater range of motion without the use of double joints. Or the elbow joint could be oval or eggshaped with an extra long slot, and when bent further than 90 degrees the tip of this oval sticks out to form the elbow bone.

A double-jointed elbow can take many forms, and I have seen quite a few different attempts from various companies, all with varying success when it comes to both posability and aesthetics. The idea is usually to fuse two balljoints together where each has a separate slot that allows a 90 degree bend. In some types one of the halves will engage first and the other only when the arm is bent further than 90 degrees, usually because there is a small catch or increased friction so that more


elbows (single)
shoulder
anterior flexion
90°
wrist
external rotation (away from body) [during flexion]
internal rotation (towards midline/torso)
axial rotation (int, ext)
int/ext rotation blocked or limited
flexion only or axial rotation while extended (straight)
flattening or cut away of both upper & lower arm = ext/int rotation + 90+ flexion
bends more than 90°
90
indent
must balance function & looks
single-joint can bend more than 90° if sufficient material is removed to allow it


elbows (double)
primary joint works as single
ledge
blade
secondary joint must be manually pulled out and locked in place
older idea for limbs
elastic has to pass through here so joint won't sit properly
twin limbs → a lesson in what not to do!
reverse double?
a possible improvement?
no need for pulling, joint should swing into flexion with little pressure after primary joint is moved out
cut
top view of lower arm
this just happens to be the way Unoka 1.5, 2.0, Unoka + Unoa elbows work...
Serendipity Ismy inspired twin-limb elbows
other types of double joints
or half elbow
sometimes the simplest solution is the least obvious & yet also the least.
Secondary flexion in upper arm (hidden) does allow rotation (ext/int) during flexion!!
Still difficult because sec. flexion must be pulled out.

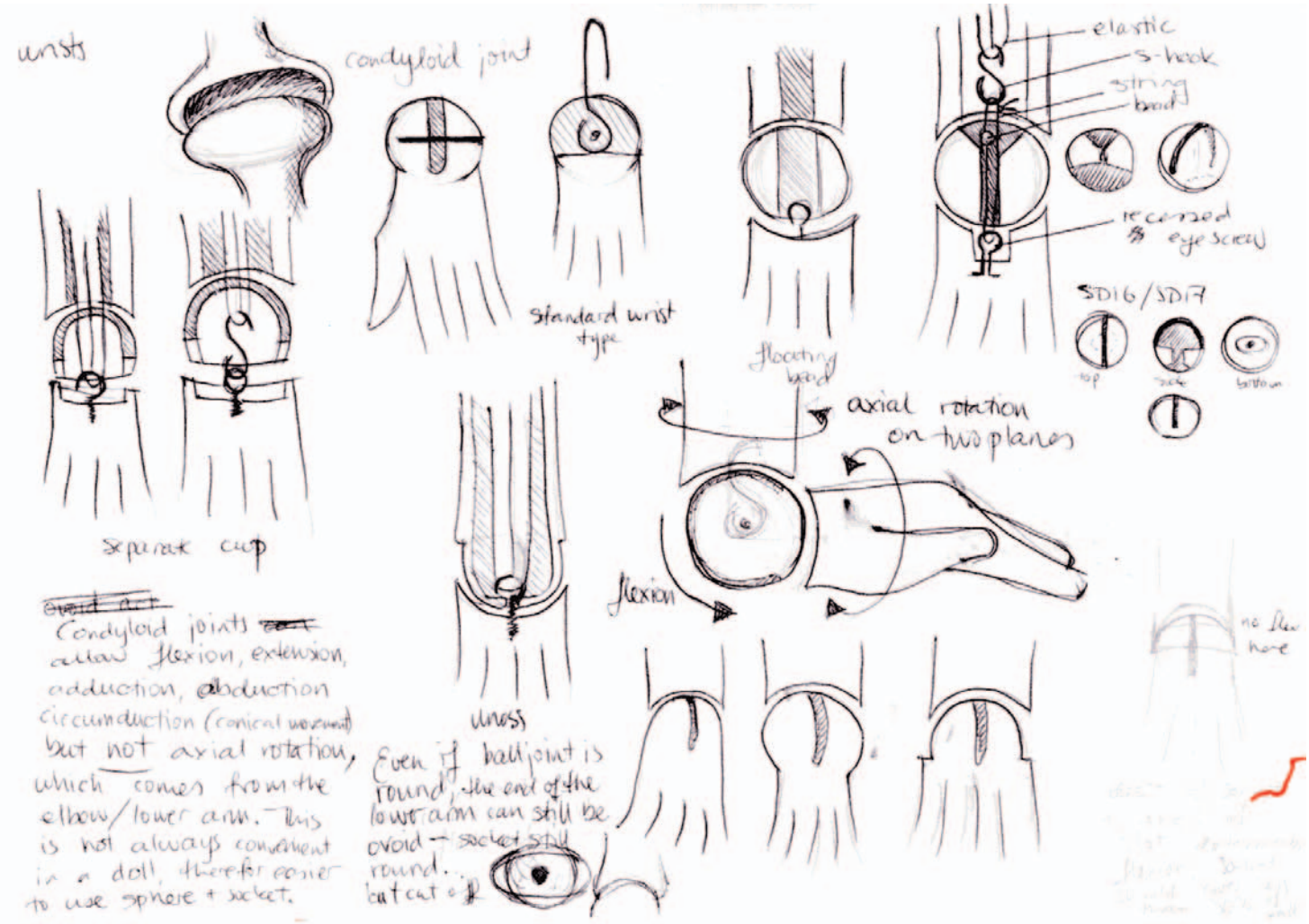
pressure must be applied to engage the second half of the joint. The elbow that I made for the twigLimbs looks at first glance as if it is a single joint, because the secondary flexion is hidden inside the lower arm and must be pulled out and rested on a small ledge inside the lower arm to function. When the arm is bent as far as it will go the arm appears longer than when it is straight because the pulled out section is otherwise hidden. The elbow will also have a square-ish appearance instead of coming to a point. Unoa 1.5 and Unoa 2.0 have a sphere at the top half and a secondary joint that sits recessed into the lower arm but is not hidden. The secondary joint has a small catch and will only bend when the primary joint can bend no further. While the joint works well, a partial gap may be visible from some angles and leaves the joint looking mechanical.

Other types of double joints allow either of the two halves to engage first and they usually work together. However these balljoints are not spherical but oval with a lump on the back; both the upper and lower arms have corresponding cuts to accomodate the lump. The lump simulates the elbow bone and makes the fully flexed elbow appear less squared. Alternatively a pill-shaped joint but without the lump on the back; the arm is cut straight and has a cutout at the front on both the upper and lower arm to allow the elbow to bend. The lack of a proper spherical balljoint means that this type of elbow will have some trouble bending the arm in across the torso, unless the slots are angled in towards it. A double joint could simply be a section of arm with a hemisphere or sphere at either end, and a socket in both the bottom of the upper and and the top of the lower arm. Alternatively it could be an extra piece that has a socket in one end and a sphere in the other and sits between the upper and lower arms' opposing ends. The result can be a very smooth-looking and working joint, but the different parts require precise engineering to make them work properly together.

If cutting the arm to include a double-joint you may need to actually cut a piece out of the middle of the arm because the elbow joint in itself will be big enough that it will distort the length of the arm. It also occurs to me that if you can make a double joint out of two spheres with sockets in both the top of the lower arm and the bottom of the upper arm, you should also be able to make one that consists of a two sockets, where both the top of the lower arm and the bottom of the upper arm have balljoints attached.

WRISTS

The wrist on a human being is a condyloid or ellipsoidal joint, like an oval balljoint with an oval socket. It can bend backwards and forwards and a little bit side to side, but wrist rotation in a human comes via the whole lower arm as the two bones inside bend around each other. On a doll, the wrist is usually a regular balljoint, either attached to the top of the hand, the bottom of the lower arm or is a separate part that floats freely between the two or in some cases nests into the top of the hand.



Even if the balljoint is round or hemispherical the cross-section of the elbow could be oval, the socket would also still be round but shorter on the front and back.

Apart from being posable, hands also have another important function, because they, like the feet are end stations where the elastic that holds the parts of the doll together must have a holding point. If the balljoint is attached to the hand, there is usually a deep slot cut into the sphere itself, and a small hole is drilled across the slot. A small s-hook is pinned in place at one end with a small metal rod, and the elastic loop is hooked on at the other end of the s-hook. On very small dolls where it is hard to accomodate for an s-hook, some manufacturers use a piece of string to attach the hand to the elastic. Other dolls, instead of the metal rod, have a piece of resin that the s-hook is attached to, while others again have a piece of resin but no S-hook, instead the arm-elastic wraps directly around the bar, which means the elastic has to be threaded via the hands before its ends can be tied. The use of s-hook or string means the slot in the wrist can be quite narrow, while without these allowing for the thickness of the elastic would mean a larger slot.

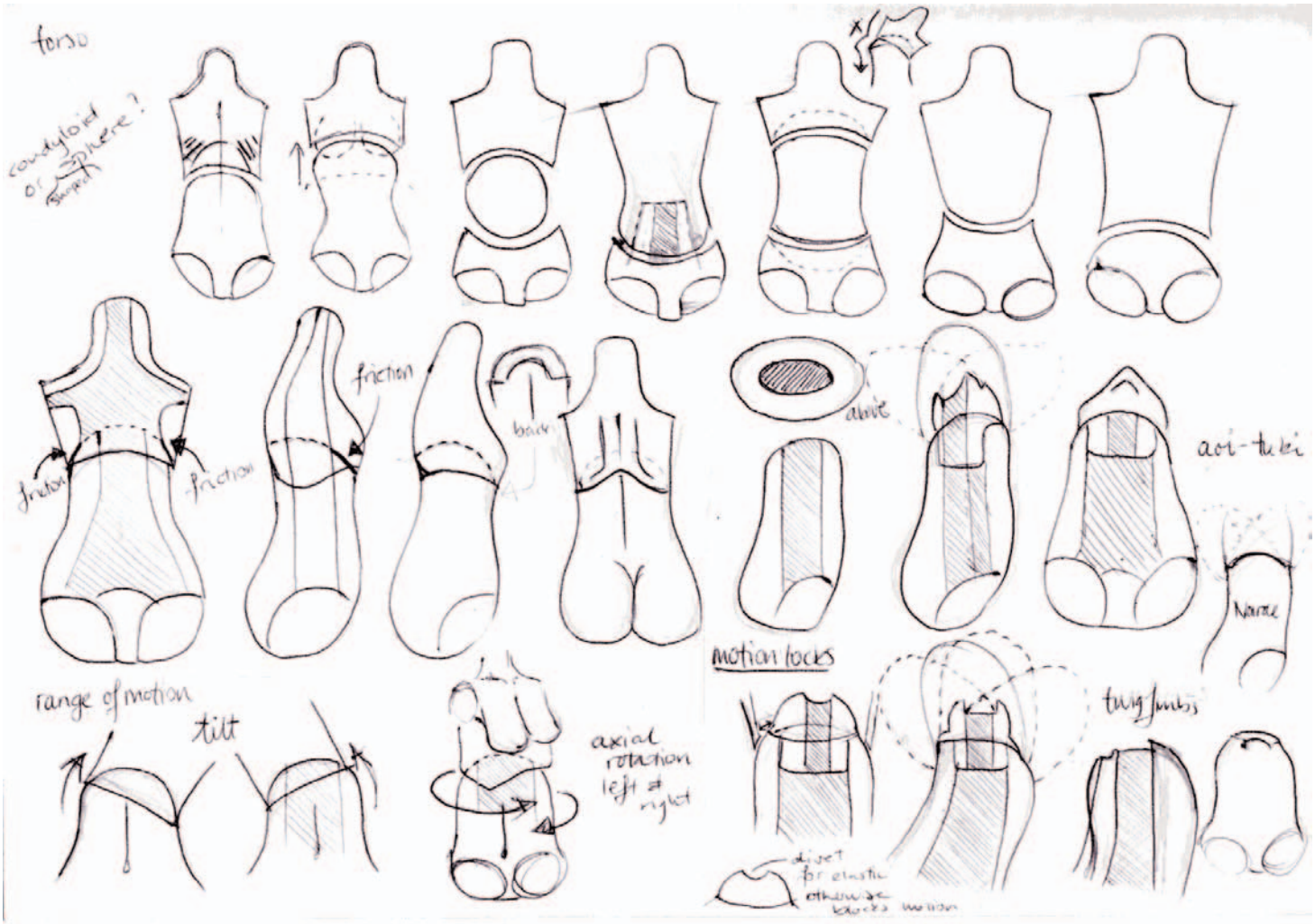
Wrists with a separate balljoint, such as on the Volks pureskin dolls have an eye screw or a cup hook attached to the top of the hand, and the elastic is attached either via an S-hook into the eye screw, or directly to the cup hook. The newer Volks SD16 girl and SD17 boy has a recessed eye screw in the hand which is attached to a piece of string onto which is threaded a separate balljoint. The string has a small bead at one end so the balljoint will not be lost. The string then connects to an s-hook that holds the elastic. While slightly complicated this makes for a very posable joint. The wrist can also be a freefloating bead with a wide hole through it, where the elastic is threaded through the bead and onto a cup-hook in the hand. This type of solution works very well because of the ability for the wrist to move independently at both the hand end and the lower arm end of the balljoint.

TORSO

On a human the torso is of course flexible along the entire spine, but on a doll the posability comes from one of two cuts across the torso. The torso joints are the largest balljoints on a doll, and are often not round at all because the trunk of the body is not cylindrical, but rather wider across the front than it is deep. That is not to say you can't simplify the structure and just make it round though, or make the end(s) more hemispherical and the trunk more oval in cross-section.

The torso joint should allow the body to bend forwards and backwards and tilt side to side. It should also allow some axial rotation. Ball joints in the torso also do not have just a slot for the elastic to pass through, but a large circular or oval opening.

For a single jointed torso the cut is usually placed along the ribcage or under the bust, or in some cases near the hipbones. In the former the socket is usually at the bottom of the upper torso, and a corresponding hemisphere at the top of



the lower torso. A double jointed torso will have both the upper and the lower joint and is of course more flexible in terms of bending the dolls' equivalent of the spine. The balljoint is rounded at the front and sides but often abruptly cut at the back. The cut across the torso is usually not straight but tries to follow some of the natural contour lines of the sculpt such as the bottom of the ribcage both at the front and back. Bodies cut closer to the midriff is a more natural point for the spine to bend, but also creates a more visible joint. Dolls with this type of joint also have the socket at the top of the lower torso and the balljoint as the bottom of the upper half.

Lower torso joints such as those of the Cerberus Project male bodies mean that you get the smooth appearance of the entire torso with a joint that is almost hidden by the presence of pants, however because joints below the waist are increasingly affected by gravity and the weight of the doll parts above, this type of joint could be very posable but is often purposely restricted by internal parts so the doll will not overbalance at the hip. The application of friction-materials may reduce the need for internal structures to improve the range of motion. Another solution might be to have a textured surface inside the concave half of the joint, for example ridges or crosshatched grooves; the convex half might have small nodules that would catch on the ridges and gently lock into a range of poses.

The Aoi-tuki body and the Volks SD16 girl both have their torso joints in the upper part of the body, but both also have significant internal structures that not so much limit the range of posability but rather enable it to work even better. By pulling the upper torso up and backwards the body can bend further backwards and lock into place so that the dolls can lay on their stomachs and face forward. I attempted to apply a similar principle to the twigLimbs body but tried to allow the locked movement to be possible both backwards and forwards into a deep slouch. I also created a small ledge where the torso would sit in a neutral position.

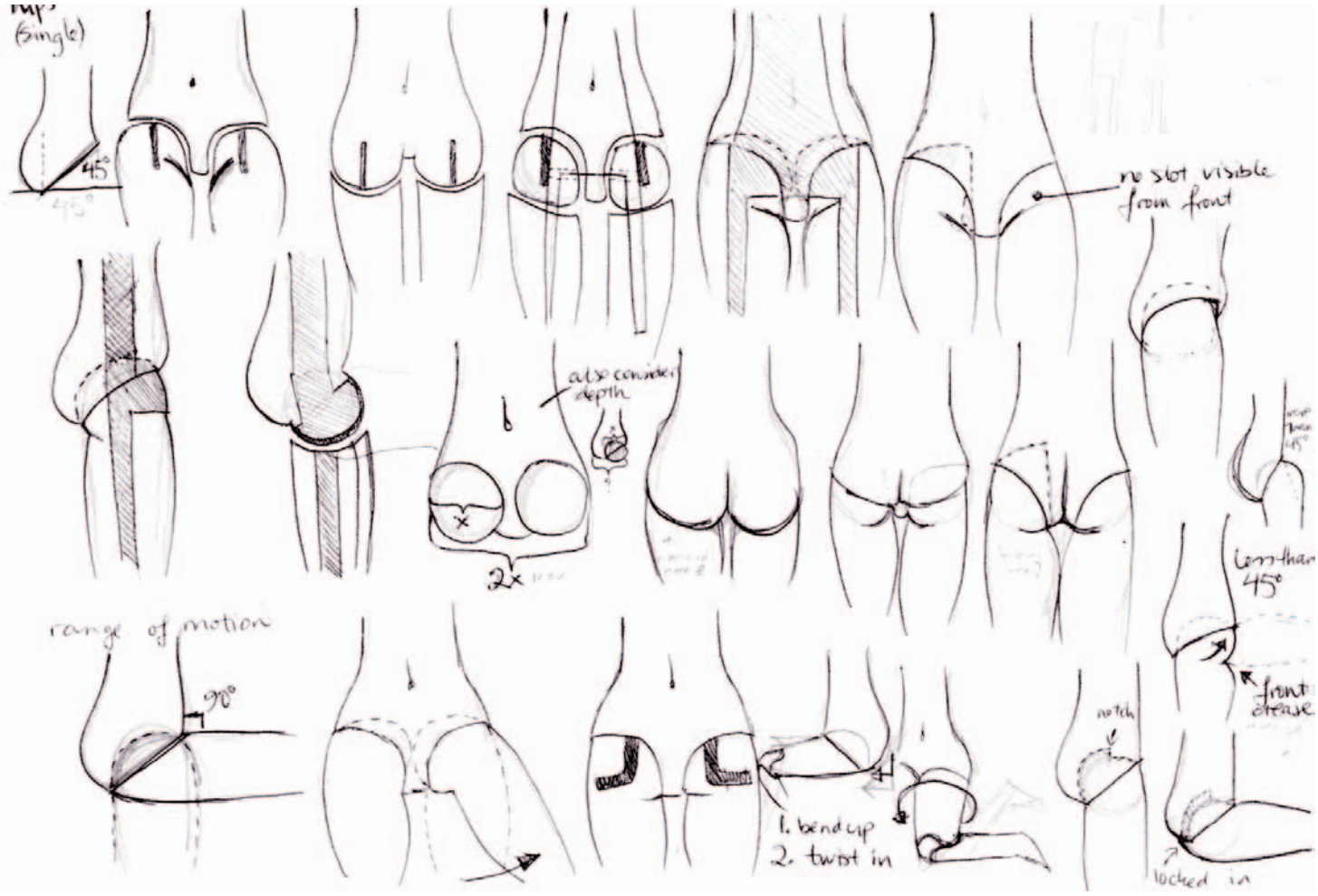
Dolls like Narindoll Narae has a small ledge both at the front and back of the lower torso that allows the upper torso to bend both backwards and forwards, but not so far that the stringing hole becomes apparent.

The stringing hole of the torso really should be as big as possible because it is a big part of what allows multidirectional movement. However the trick is to balance its size so that it is not visible whichever way the torso is posed. Similarly there needs to be enough surface for the socket half of the torso to rest on and friction against.

The torso is the part of a ball jointed doll that most commonly is sculpted without any jointing at all in order to have a smooth and sculptural appearance.

HIPS

From the hip down balance really starts to become an issue because of the weight of the head, torso and arms. Hips should bend forward and ideally also out to the side. They may also have some axial rotation, but this is not very necessary as legs that spin freely often end up with knees facing backwards. Rotation when the hip is bent to 90 degrees can however be useful



for a doll to be able to sit crosslegged or in the lotus position; several different mechanisms can be put in place to allow for this.

The ball of the hipjoint can be attached to the top of the thigh, or to the lower front of the torso. It can also be a separate piece between the torso and the thigh, and in this case it is most likely a double joint where half is hidden inside the upper thigh and can be pulled out into hyper-flexion so that the doll can pull its knees up to the body. The hipball can be attached to the lower front of the torso this means that the hipjoints will stick out from the torso, and look obvious.

The buttox is most commonly a part of the sculpt on the lower torso, and the hip socket is at the lower front facing forwards and down at roughly a 45 degree angle; this to facilitate the legs being straight for standing or bent to 90 degrees for sitting. The size (diameter) of the hipjoint can be just under half of the width of the hip but you should also consider the depth of the torso itself. A larger hipjoint could make up part of the buttox curve as well. For best stability and appearance, the hip joint should allow the buttox to touch the surface when the doll is sitting and not hover above it while the doll sits on the back of its thighs.

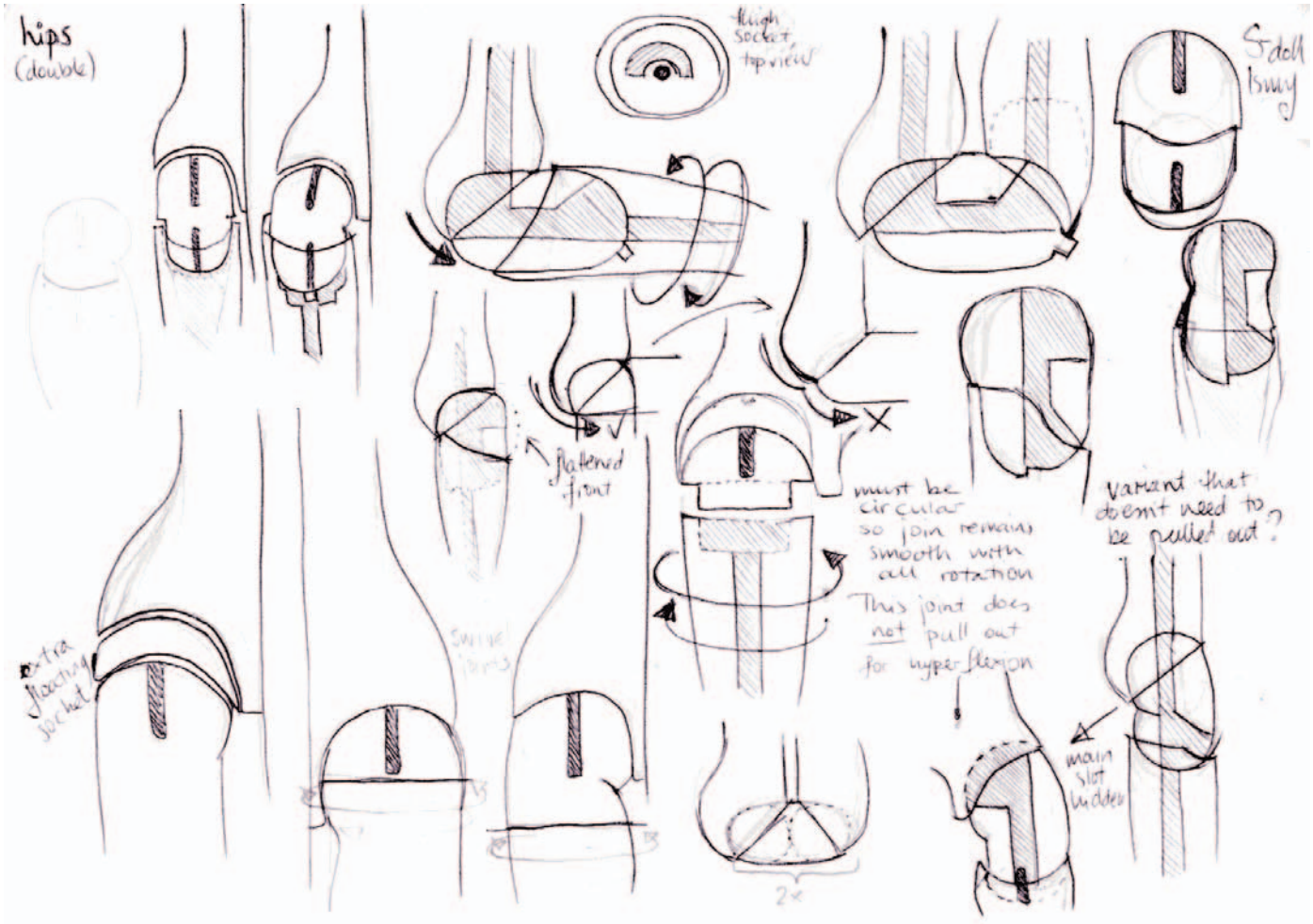
Some dolls have a ridge on the top of the hipjoint that corresponds to a groove inside the hipsocket. This prevents axial rotation when the leg is straight and locks in under the edge of the buttox for a smoother appearance when the doll is sitting.

The slot in the hip most often faces straight forward, although this is quite limiting on range of motion beyond bending to 90 degrees for sitting. The slot can also face in towards the middle of the body and be invisible from the front. Slots can even be curved outwards so the doll can sit "cutely" (suwarrico) with its knees together and the lower legs pointing outwards or backwards.

The Cerberus Project boys have a cup or shim inside the hip that allows some extra movement of the hipjoint. Some newer dolls also have a cutjoint at the top of the thigh below the balljoint, which allows axial rotation when the doll is sitting. This would be in place of the curved joint, and requires precise engineering to make sure the two parts sit neatly together whichever way the joint is turned.

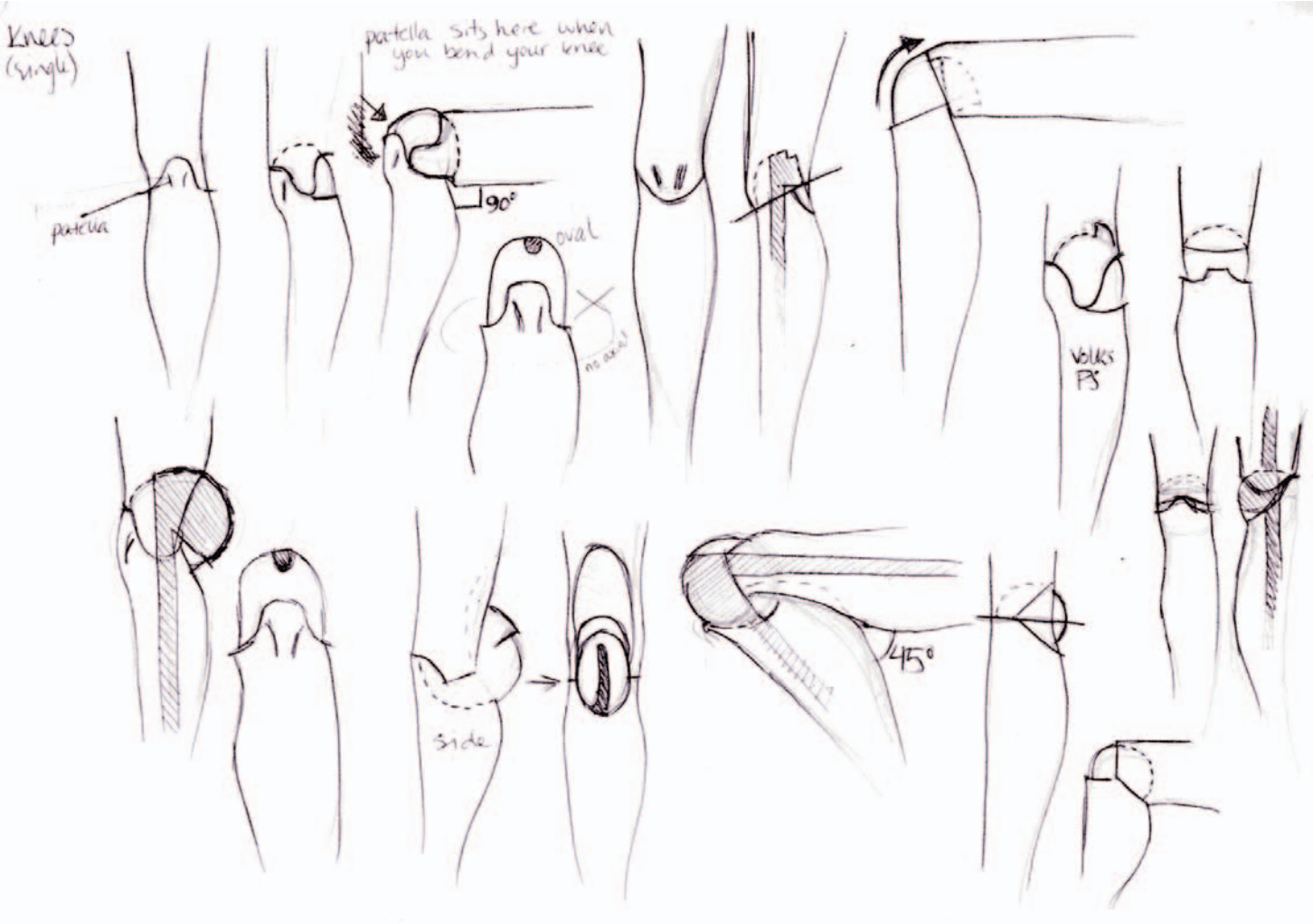
Some dolls have a very obvious sphere at the top of the thigh, while in other the sculptors have tried to blend the sphere into the sculpt of the thigh. To allow the hip to come to a proper 90 degree bend it is often necessary to make a groove at the front of the thigh, right where the balljoint ends and the thigh begins. This means that the joint works well, but the groove will look strange when the leg is straight, because it looks like the groove really should be on the back. One way to counter this might be to flatten the front of the balljoint down to the bottom of the groove, as the spherical element is mostly necessary where it connects with the socket at the back of the thigh.

It is tricky to balance the various elements of the hipjoint so that they work well and look good, but it helps to be aware of the problems that can occur up front; this way steps can be taken to prevent them. As with all the joints, careful planning of where to cut and what type of joints to use means there will be fewer surprises once you start and you will be better equipped to deal with any surprises that do come up.



KNEES

The thing about knees in dolls is that they need to be able to support quite a bit of weight and be stable so as not to collapse under the strain, but they also need to be flexible and bend to at least 90 degrees and preferably more. Single jointed knees will have a balljoint attached either at the top of the lower leg or at the bottom of the thigh, the former being more common. The patella can sit either above or below the cut, but on a sitting human the patella will sit right on the 'corner' of the bent knee. As human knees have no axial rotation, the kneejoints in dolls are often not spherical. Using spherical joints in the knees would mean the balls would have to be quite big because knees need a large surface area to spread the tension on to keep the doll standing up. Another problem for this is that the spherical knee would be too bulky in relation to the rest of

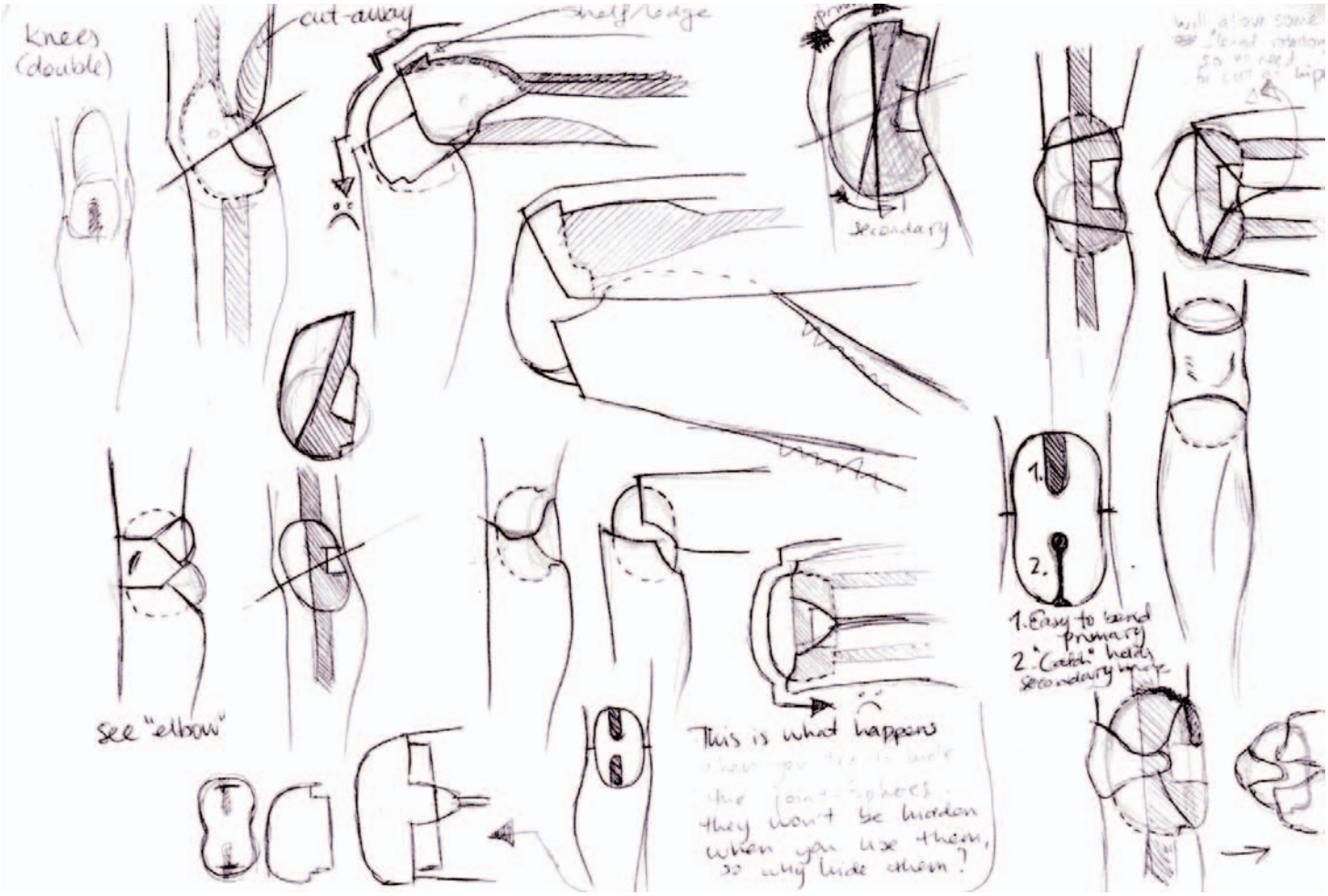


the leg. Knees are rounded and perhaps even round in profile view, but from the front they are usually either somewhat flattened or even shaved down at the sides. The newer pureskin Volks dolls also have small 'teeth' at the back of the hemisphere and corresponding grooves inside the socket that lock in to keep the knees straight and help the doll to stand unaided.

Some dolls have a very pronounced circular profile of the kneejoint, and teamed with a generous cutout at the back of the thigh, this allows a flexion of greater than 90 degrees without the use of a double joint (such as on Ismy).

A knee that is cut diagonally from back to front with the lowest part of the cut being at the front, are often fairly smooth at the back, so that when the leg is not bent it is hard to see that the joint is there, aside from the actual line where the two parts meet and the stringing slot at the back. This type of kneejoint often also has a little ledge or dent cut at the back of the hemisphere, so that the knee locks into 90 degrees and the curve of the knee is then smooth and not jagged.

Dolls' knees look quite square and chunky when they are bent further than 90 degrees because the rigid form doesn't compress like on a human. They are well suited to double jointing provided the joint with its extra socket is strong enough allow the doll to stand unaided without suddenly collapsing under its own weight. A lot of what applies to the elbow can also be said for the knee when it comes to double jointing but unlike with elbows you do not need to worry about allowing for much axial rotation (unless you have decided on a relatively rigid hipjoint); you can either have a joint that is hidden when the knee is straight or you could have knee that makes up a visible part of the leg. As with elbows you can also either have a primary and secondary flexion, or the two halves of the kneejoint could work together to create a 90 degree angle as well as sharper angles. In the case of the former, the secondary flexion will need to be locked in and not function until after the primary has been engaged. But at the same time you don't want to have to pull the secondary function into place with a lot of effort, it should simply want to bend out when the primary function is bent as far as it is meant to go.

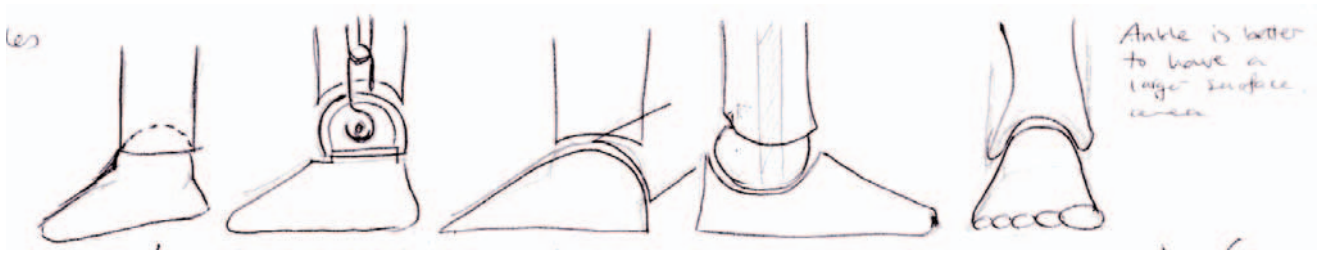


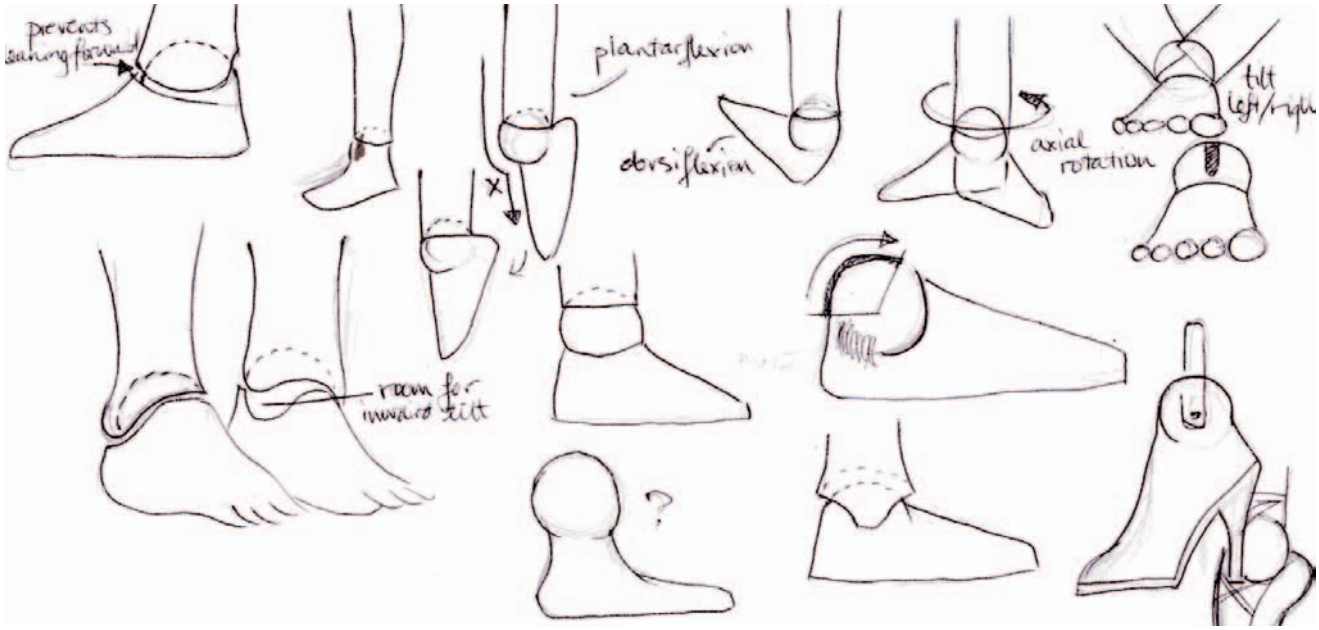
ANKLES

The ankles do not really need an awful lot of range, the most important thing is that they are solid enough to allow the doll to stand up. The ankles are after all the joints that need to carry all the weight of the doll. Like the wrists they are also an end station where the largest elastic connects the legs via the torso up to the head. The ankleball can be attached to the foot, or to the bottom of the lower leg. It can also be a separate bead or a hollow cup, covering an eyescrew, a cuphook or a built in resin hook that holds the elastic in place. The ankle should be round or hemispherical and should allow some axial rotation, it should also be able to bend forward to bring the toes pointing sharply down (plantarflexion). In contrast I have not seen a many dolls with ankle joints that allow them to point the toes upward as you would if crouching down (dorsiflexion). I believe this is mainly because the weight of the doll will easily cause it to fall forward if there is no support at the front. However with the use of friction materials the ankle joints can be made very stable, so there is no reason not to experiment with them.

If you decide to use a separate ankle joint, it is probably a good idea to have it somehow lock into the foot with some sort of notch and with the help of the pressure from the elastic. Because you've already most likely got axial rotation between the ankle joint and the lower leg, you don't need to give it that extra movement, with ankles the focus is more than anything to make them stable.

For a doll that will be able to stand unaided, flat feet are the way to go, but arched feet that can wear elegant shoes can also be an option; or what about feet that are sculpted to look like shoes?? By the way, flat feet don't need to be completely flat underneath, as long as they have several points (more than two) at the same even so the doll has something to stand on. If a joint in the ankle is going to cause more trouble than it is worth, consider omitting it in favour of a more aesthetic appearance.





MAKING BALL JOINTED DOLLS

DESIGN & PLANNING

If we consider or trust what we see without basic knowledge of what we are trying to sculpt, the result will be very superficial. Therefor it is beneficial for the artist to obtain knowledge about how the human body is put together. Human anatomy is a subject all to itself, but I seriously suggest looking at some anatomy books that are specifically aimed at artists, just to achieve a rudimentary understanding. You don't need to know the name of every bone and muscle, but it's a good idea to know what parts are visible from the outside, what they look like and what their function is. Both from a visual point of view so that things are put in the right spot, but also from an engineering point of view to better understand the way joints work, their limitations and construction.

A well executed product should always start with an idea that is explored on paper before you ever start kneading your clay. This might mean sketching and drawing or collecting a scrapbook of images that inspire you. In this case it also means having a plan and a layout for the way the doll will be jointed. The layout should be drawn in the actual size you want to sculpt, and should show the doll from the front and in profile, it should also show where the different joints will be, how big they are, and indicate what shape they will have.

Perhaps the doll will take a different direction once you start sculpting, perhaps you'll change your mind along the way, or you find that things won't work the way you had intended but the layout gives you a map to follow. Further, by making most of those decisions up front, you'll be able to collect all the materials and tools you need before you start.

Partially how you do things depends on whether you are making an original one-off doll, or you are sculpting a master from which molds will be made, but either way you will probably want to have somewhat hollow parts so that you can easily test-string and check the fit and balance of the doll at any given time. Tutorials like Haru's doll, Noah's doll, Torame's doll and Yoshida's guide are all instructions that show how to make a one-off art type doll, which is generally a hollow shell, and uses steel pins or piano wire inside all the balljoints to control where the elastic string sits. A doll that will be cast can be completely solid and the stringing channels can be drilled afterwards, or you can use core-molds when casting to save on cleanup-work and materials. In this case the stringing channels will guide the elastic and the resin be more than just a shell.

Your choice of materials will also be determined by the purpose of the doll — but whether one-off art doll or master prototype your doll is probably not going to be suited to a lot of rough handling.

AVES APOXIE SCULPT

Apoxie Sculpt is a two-part sculpting compound which is mixed 1 to 1 by volume to make a self-curing clay. It has a 2-3 hour working time which can be accelerated by exposure to heat ~ complete cure takes 24 hours. During summer in Australia, I put my pieces in a black box and leave it out in the sun for a while. It is freeze-thaw stable, so you can store it unmixed in the freezer and it will last forever; in room temperature it will last for about a year before it gets hard to work with, although you can heat it up to soften the two parts and make them workable again. Apoxie does not shrink and it isn't toxic, nor flammable. It doesn't taste very good, though. It can be sanded, drilled, polished and painted. You can even tint it

with pigment powders or acrylic paint when you mix it, but tinted apoxie will tend to change colour over time; untinted apoxie is not UV stable and will start to go yellow. High temperatures will also make it yellow. Adding paint to tint it will make it more sticky and slow down the curing time. Apoxie comes in a range of colours, but for basic sculpting like we are doing here, I recommend using white or beige (which is really grey). Darker colours will go light when you sand them.

Apoxie starts out very soft and a little sticky but firms up if you let it sit for 15-20 minutes. If you start sculpting straight away the clay will sag a little bit, and if you 'cook' it too early it will take shape from the surface it is placed on, so I suggest making something that it can stand on or hang from in the oven without deforming from touching any surfaces. 10-15 minutes at 200 F is sufficient to harden apoxie, but the surface will be very hot so let it sit and cool before handling or adding more material. It is easier to mix up smaller amounts rather than making a large batch and then finding that starts to cure before you've had a chance to use it all. It's a good idea to wet your fingers and tools as you're working to stop them sticking to the soft clay; use water or vaseline or even talcum powder. If you collect the dust from sanding apoxie you can even use it as "flour" when you're working with unhardened clay.

It sticks to most things, especially to itself, so it's excellent for adding more material to a cured piece to sculpt in stages. If you're trying to make it stick to a glossy surface it may come off once cured, so try to rough up the attachment point before adding clay.

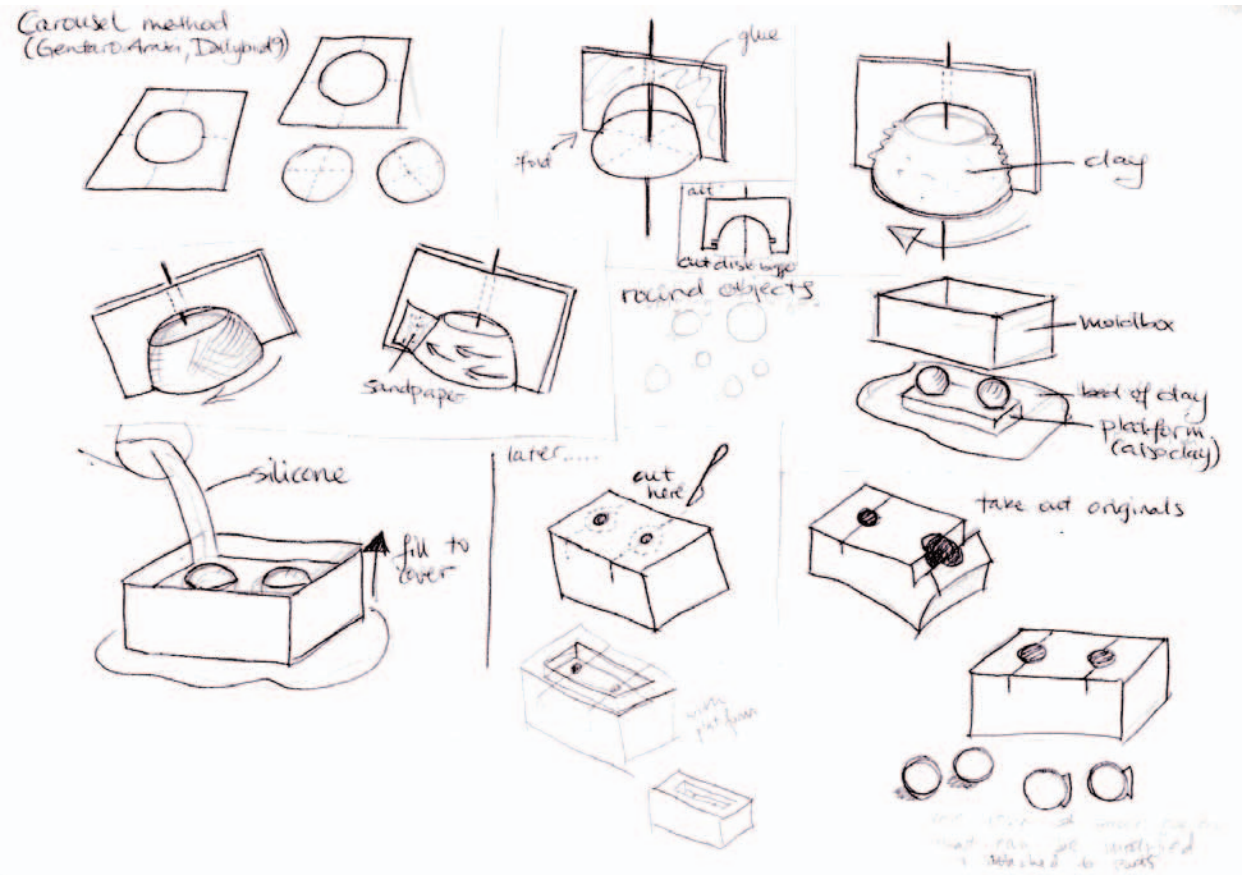
One of the down-sides to apoxie is that while it's very hard it doesn't have a lot of give, so thin parts will break rather than bend. It is also very important that you mix the two halves very well otherwise the material will not cure properly, so mix it till it is a uniform colour and a blended consistency; you'll notice that the two components have different textures and when you mix them you get another texture again.

Aves Studio also has a range of other sculpting products that are worth checking out, but my experience has mainly been with Apoxie, which I have been so happy with that I haven't wanted to try anything else yet. And no, they are not paying me to say this, but I wish they were!!)

HOW TO MAKE JOINTS, SOCKETS & SPHERICAL OBJECTS

I usually just hand-roll my balljoints over a core, but in future if you prefer to make sure your spheres are perfectly round, you can use round objects like marbles and balls to make simple molds from silicone or hotmelt vinyl. You can use the molds either as pushmolds for clay, or to cast resin spheres.

When you hand-roll your sphere's they probably won't be completely perfectly round, but remember that in most cases once you attach the sphere to a part to make a balljoint, there will be one side that is flattened or merged with the part. Also, you can only do so much with the clay while it's still soft, so once you've got it roughly rounded, put it to rest on a flat surface. When the clay has hardened, you can sand and file the surface to make it smoother, or add a bit more clay here and there if some spots are too flat.



For larger spheres you can use a trick that Gentaro Araki suggests, let's call in the 'carousel method': use heavy cardstock and make a rectangle cut out a sphere of the size you want the joint to be from the middle, and fold the cardstock in half and glue it with a skewer at the axis. Make a hole at the center of the circle you cut out and put a lump of clay shaped roughly like a hemisphere on it before you skewer it at the bottom of the contraption you've made. Spin the arch round and round and the clay will be scraped into shape. When the clay is hard you can hold some sandpaper in the arch and spin to get a smooth surface.

When you cut out an opening that will become a socket, you may want to make the opening a little smaller that the sphere you intend to fit in it. A socket that eats 50% of the surface of the sphere may have a lot of grip but you will not get a lot of movement out of it without having deep cuts in the part itself. I recommend working with shallow sockets and larger spheres to get the maximum movement out of a joint. Point being that the size of the hole determines how far in the ball will sit and a hole that has the same diameter as the ball will eat half of it if the socket is filled.

If you use the hole as socket without adding a bowl to it, you are exposing the edges to a lot more stress. While a curve is stronger than a straight line, you'll still want to distribute the pressure across the surface of the socket by filling the hole with clay and pressing the lubricated balljoint into it to make the right shape. A filled socket will also have much better friction.

PROCESS

A full doll can be sculpted in two ways: as a neutral figure in one piece, which is then cut up where the joints are to be placed; or as a set of separate pieces — or a mixture of both. The resulting pieces are then reworked to have balls and sockets, then detail is added and finally the surface is cleaned up. Because you are bound to loose a bit of detail where you cut, I recommend not adding too much before you cut unless you are willing to build it up again.

Personally I did a bit of both when I was building the twigLimbs, and I think either way is fine, there is no right or wrong way to go about building a ball jointed doll, but there are definitely many shades of making it harder or easier for yourself. The former may be easier to do because you get a better overview of the proportions and the holistic appearance of the doll right from the start, instead of having to do a test-stringing to be able to see how the doll will look. By cutting up a one-piece figure, you already instantly have basic parts for arms, legs, head and torso; and these parts belong together in such a way that it is easy to put them back together again when you've added the balls and sockets.

Many tutorials show artists using styrofoam as a core material inside the doll parts. The artist, using the 2D plans for the doll as a base, draws the flat silhouettes of the different parts onto blocks of foam at the front and sides and use a saw or knife to cut out rough shapes. The sharp edges are then rounded off, and covered with clay.

There are benefits to using this method because you get skeleton parts that are perfectly suited to the size and scale you have drawn your plans. But equally, cutting the foam makes an awful mess of statically charged foam particles, although you can use anti-static spray and tools that are made for cutting foam. If you are using a clay that requires baking, or you are heating the clay to speed up the curing, using styrofoam is bad because exposing it to heat means it will melt and evaporate into a very toxic gas.

Even if you don't need to bake your pieces, you will probably need to remove the foam after the clay is dried. The safe way is to rake and scrape the foam out, which creates more of that static mess to clean up, or put a few drops of acetone on, which will melt the styrofoam away, but also create harmful fumes as the material is dissolved.

Using scrunched up al-foil is another method, and it is definitely good if you are using a clay that needs baking, but it is not very easy to get out of the parts.

Both styrofoam and al-foil can be wrapped in tape or cling film to help stop the clay from sticking to the core, but it doesn't really make it any easier to get the stuff out afterwards. You can of course cut each part in half lengthwise to remove the core material, and then glue the halves back together.

Another method might be a variation on the "lost wax" casting, where your basic parts are sculpted from plasticine, chilled in the freezer and wrapped in cling wrap. An air drying or chemically curing clay like Apoxie is then added on the outside of the cling wrap and left to set. When the outer shell is hard, the plasticine can be melted out. Exposed to heat it will become liquid (and hot!) so suspending the parts above a suitable receptacle and placing in the oven or near a heat source should produce results quickly. The plasticine will harden again as it cools and can be used over and over.

My favourite method is a lot less sticky though. It is ideal for parts that are bigger, like the head, torso and legs. Using your 2D designs as a guide, you determine how thick the clay layer should be and figure out how big an inner core needs to be to allow that thickness of clay without making the doll bigger than the plans. Then you make a simple pattern with a seam allowance, and using calico or cotton (non stretchy materials) sew a pillow or a tube of fabric. One end is sewn shut, the

other left open. The shape is filled with beach sand, or dry rice grains and the last opening is sealed off with a rubber band or a knotted string. The whole thing is wrapped in masking tape or cling wrap and then covered with clay. The tape and cling film can also be used to subtly shape the part before you add the clay When the clay is hard, all you need to do is open the fabric pillow and let the sand or rice out, then gently pull out the fabric.

If the thought of thin-shelled parts scare you, sculpting with a lightweight paperclay over straws or tubing might be better. The straw makes an opening that is big enough for the elastic to pass through, but still allows the part to have nice thick walls. Drinking straws will melt and warm and create nasty fumes if exposed to too much heat, but it should be safe to cook them at around 200 F. Using a lightweight clay also keeps the weight of the part down, and makes it easy to cut away some of the innards where you need to add sockets.

Simply sculpting over hollow objects like tubes, cylinders and plastic bottles is also possible. I originally wanted to sculpt a torso over an empty shampoo bottle, but determined that the shape of the bottle would dominate the sculpt and stop it from really being anatomically correct with regards to posture and placement of surface detailing.

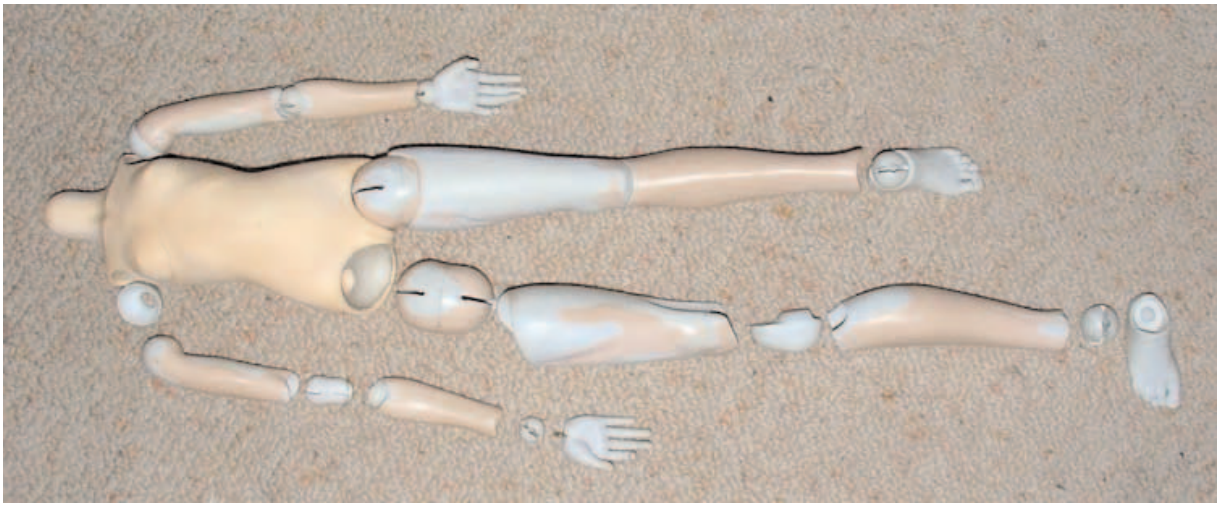
For thinner parts like the arms you don't need a lot of padding, just sculpting directly onto rigid straws or tubing should be enough. For the twigLimbs arms I used 16mm electrical conduit and it was probably a bit on the big side. When I sanded the putty back, the conduit ended up showing through in some places.

Using a wire armature to build the hands and feet helps strengthen the thin pieces of clay that make up the fingers and toes. I sculpted the palm and thumb in one piece and then each of the other fingers on a doubled-up piece of wire, then glued the fingers in place on the hands after I had detailed each of them. The feet I sculpted first as a sole, then I built up the foot-wrist and finally sculpted on one toe at a time starting with the big ones and waiting till each one was dry before detailing it and then sculpting the next one in line. The toes were sculpted without any wire because they were not separated, where the fingers have gaps between each digit.

Once the parts are dry and hard, you need to draw on them to indicate where you want to cut, first a line across to indicate where the part will bend, then more lines that show where material must be cut away to allow the part to bend. Also make a line that is perpendicular to the first, which shows where the two parts (when cut) will meet up.

Doing a curved cut is going to be tricky with the tools I have prescribed, so you might need to cut straight from two directions and then glue/repair some areas. Glue is a good near-instant bond, using apoxie is a good reinforcement, but will need time to cure before you can handle the piece and continue working on it.

Using a small saw you cut the part in half and then cut or file away the areas that will allow the part to bend. Attach a sphere to the correct part, probably not a whole sphere, but one that has been cut down on one side, the flattened side will be attached to the limb-part (remembering that more sphere surface equals more movement). Allow the glue to set. Then the limb end that will be the socket that docks with the balljoint you just attached is prepared by adding some clay to the opening, the balljoint is covered temporarily with a tight layer of clingwrap and the socket should be lubricated with water or oil and then the ball is pressed into the soft clay to make an imprint. Press and twist gently, and remove the ball. If the cling film sticks, let it stay as it will be easy to remove it later. Let the clay harden a bit and then press the balljoint in again to make sure it still fits. The clay is more firm, but will still be able to be manipulated. When the clay in the socket is completely hard, you can carve and sand or sculpt and build up the edges to make them neat. You will also need to drill a hole at the bottom of the socket for the elastic to pass through. Also test the fit between ball and socket again and move the joint from static to flexed position to see that it is allowed to bend as far as it should be able to. If not, you may need to cut away or flatten the limb where the flexion is hindered. When the joint works as it should, you can start sculpting more details and shape the parts further, but keep testing the joint to make sure what you are adding isn't getting in the way. Also do tests with elastic to get a better idea of how everything is working.



ABOUT TWIGLING aka. Therese Olsen

I originally come from Norway but have recently become a permanent resident of Australia where I have been living for the past 6 years. I come from a creative background, my parents are both eager hobbyists who enjoy working and making things with their hands, which has rubbed off on me. I've enjoyed playing with dolls of various sizes throughout my childhood, and remained peripherally interested as a teenager also, although I moved from Barbie towards handmade types of dolls. Still I was constantly driven by a desire to make things, specifically dolls and figures and I borrowed craft books from the library to find new ways to make things. When I started senior high school I was able to elect a vocational line of training concerned mainly with drawing, form and colour, and from thereon I studied graphic design at university. In hindsight I probably should have picked industrial design instead, but at the time I thought that graphic design would make it easier to get a proper job after graduation.

As a student my interest in dolls was re-ignited and I found a small group online that collected and customised 12 inch female action figures. I was quite taken by the range of motion in these figures, and for a time I was obsessed with making the mechanical looking dolls appear more human without loosing their excellent poseability, which was a big step up from what I had seen in fashion dolls.

Eventually I discovered the world of asian ball jointed dolls, staggered at the price and started saving. I bought my first one as a reward for finishing my honours degree; with funds I had gotten from knitting for dolls , as well as a generous boost from my student loan. However I was disappointed with the relative lack of posability that I had become accustomed to with the smaller action figures.

Photo by Britta K. Bergersen

LINKS

Make

Google Translate ~ http://translate.google.com/translate_t
Noah's Doll ~ http://www2d.biglobe.ne.jp/~dhnoah/make_00.htm
Haru's Doll ~ http://www.ne.jp/asahi/haru/doll/make/makeindex.htm
Torame's Doll ~ http://torame.fc2web.com/home/esthe/ogre01/ogre01-1.htm
Futoyama's Doll ~ http://www012.upp.so-net.ne.jp/futoyama/Htm/Howto/workroom.htm
Oshizaka/Aimi's Doll ~ http://www.aimi-doll.com/howto/index.html
Shuen's head tutorial ~ http://noxiv.cool.ne.jp/dreamscreator/BJD/Otino01record/eng.html
Lewis Goldstein ~ http://www.lewisgoldsteinartanddesign.com/SculptingTutorialFS.htm
Marika Spijkers, sculpting hands and feet ~ http://members.home.nl/m.spijkers/faerie-en.htm
Vivien Hoffpauir ~ http://www.vivcore.com/dolly_daydream.html

Be Inspired

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http://www.ki.rim.or.jp/~miho/
http://art-tong.com/
http://shadows.4oni.com/gallery.html (Pat Lillich)
http://www.enchanteddoll.com (Marina Bychkova)
http://pygmalion.mda.or.jp/sizuku/
http://www1.odn.ne.jp/~aaa68230/DOLL/68/DOLL68.HTML (Look at the elbows, not the gazoongas)