

Anatomy of a Design

(Or what you need to know to digitize)

When you sew out embroidery designs on your machine, why is it that some are wonderful and do exactly what you expect them to and others are horrible and make you want to hurt either the machine or the digitizer, or both?

As you have probably guessed by now, all designs are not created equal. With the wonderful new machines and great advances in both stabilizers and threads, we can make almost anything sew out well enough in the end but we are often stuck with bullet proof embroidery or other effects that we would rather not have had, including color confusion, broken threads, off line outlines and a host of other minor ills.

We commonly forget that what we see on the computer screen is not a real version of what will happen at the sewing machine. Designs that look really good on the screen often have hidden problems that will make them less appealing after they have sewn out and designs that look a bit funny on the screen might be wonderful sewn out.

The best way to avoid problems in both your sewing and your digitizing is to learn about the basics of good embroidery design, which we are calling “anatomy”. Digitizing is an art form that encompasses art, physics and logic. Thread has physical properties, as does the fabric you are sewing on and unless you want to sew out all your designs cardboard stiff fabric, you will need to work with the physical properties you are dealing with and to do it in a logical matter. Once you have a grasp of these factors, you will be able to sew out any design with no problems and digitize professional designs.

Watch your machine sew out professional designs, and you will learn a world about digitizing. If the design is sewing out very well, with no problems, look at the stitch length and the fills, the understitching and the path that the sewing follows. If it is causing you fits, decide what is wrong with the design and how it could be improved...did the digitizer follow the basics for a well-digitized design?

Before we talk about the individual components of a design, we need to understand a bit more about how digitizing programs work. There are a host of different programs and they all claim features that are awesome –but what are they really and how do they work?

Autodigitizing is a feature where your program “reads” the graphic and spews out a design based on the artwork you opened. Neat! You bet, but lots of inherent problems.

1. Two types of programs and each causes its own set of issues.
 - a. One works from colors and outlines, here the graphic must be really clear or the program will make mistakes discovering the parts and you'll spend lots of time cleaning your graphics for the best result. This type of autodigitizing often doesn't give enough overlap to avoid registration¹ issues in sew out, so you also spend time working to correct the registration of your design.
 - b. The other works from True Vector (object) types of graphics. These graphics are created of objects that overlap (example: a hand is five sets of 3 ovals for fingers set on a round shape for the palm). While this is fine for graphics –it gives digitizers WAY too much overlap for proper registration and way too many stitches overall.
2. Either type of autodigitizing works best with graphics that were created just for autodigitizing for embroidery. Sort of like “fast food” digitizing! Why spend money to purchase special graphics so you can autodigitize –you might just as well buy the designs already tested and save yourself the time of correcting the images. Some unspecific graphics will work fine, but the large percentage of graphics you can find won't work very well for autodigitizing.
3. If you can't find specific graphics for digitizing –you best bet will be with very simple graphics (and those you can do pretty quickly manually once you learn the program). Lots of fancy stuff with textures and open areas that makes drop dead gorgeous embroidery can't be done by autodigitizing.
4. Autodigitizing lacks form consistency. You and I know that the wheels on a car are all about the same –color, material and function. But, an autodigitizing program analyzing a graphic where the color was changed on the back tires to indicate they were farther away and the body of the car overlaps some of the tires might find 4 different colors and 4 different types of objects. And, we are back to having to manually make all the corrections so the design doesn't look so funky.
5. Either type of program, even if you find graphics that your program can use that aren't too simple, you are STILL going to have to know how to use your digitizing tools to put things in the proper order, bury connections and make any corrections that your designs need.

¹ How two parts of a design meet –they should not gap, but overlap properly to produce a smooth and even finished design.

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Semi-Autodigitizing is nothing more than a tracing tool that allows you to select your tool and then tap to set the boundaries of your objects. You are still going to need to know how and when to use all the tools, and the particular settings to get your design done correctly. One disadvantage is that they don't do overlap/underlay for proper registration, so you will probably find yourself editing the objects anyway.

Manual Digitizing is nothing more than manually outlining your objects and then selecting the properties (parameters) for those objects to complete your design. It was called "manual punch" long ago when each stitch was punched to the computer card by hand, but that's ancient history. Few (if any) totally manual stitch programs are still out there.

The next level worked with stitches as well and let you use one of three types of fills to complete your objects (old Pfaff Creative Designer for Windows was this type of program). Your file was a stitch (machine format) file at all points in the digitizing. Mistakes required erasing your stitches or starting over. They have minimal choices and require lots of dedication to complete designs –but, there are a few hardy folks still using these programs.

The current programs are where you work on an object/outline file (totally different than a stitch file) to create the parts of the design, then create your fill based on an amazing array of choices and finally create your stitch file at the end of the process. A completed design has 2 files, your outline/object file and your stitch file. Most newer programs work on this same basis –some even include graphic software as part of the package, others include editing software.

Alphabet Software are predigitized alphabets offered or included as part of the digitizing package. Most have limited size adjustment noted somewhere in the file or program and were created to give you the best look for doing lettering quickly. Some programs include monograph alphabets with two or three colors, others include printer's ornaments (little geometric things or curlicue designs) for instant fancy monograms.

Font Engine or Font Generators are programs that use an autodigitizing feature to convert any font on your computer into an embroidery design. They work differently depending on your base program –some magically spit out an entire alphabet at a single command, while others will let you access word art tools like graphic program have. Some even work with wingdings² to let you create instant designs (autodigitizing rules apply –it still works better with simple wingdings).

With a Font Engine, you need to know how to use the tools of both the digitizing program AND the particular Font Engine Window. All fonts are not created equal –so while having a font engine expands the number of fonts you can quickly use, you may not like the results. Font Engines usually serve a different purpose from Alphabets, most programs offer both so you can either pick from the predigitized alphabets or edit something from the Font Engine.

What's in a Design

When you are embroidering a design, you come across various pieces and it's time that we all understand what they are and what they do.

1. Underlay –this can be a zig-zag, a grid, a center run or edge run of stitches that sew under the whole design or under various parts usually before the fills. Underlay serves a host of purposes and most good designs have underlay.
 - a. Supports the objects and minimized movement of the design.
 - b. Holds the design together.
 - c. Increases the coverage of the fill stitches.
 - d. Holds down nappy fabric.
 - e. Minimizes jumps and connects individual objects together.
 - f. The larger the objects –the more necessary the underlay.
2. Pull Compensation –this is both a setting and a visual effect.
 - a. Pull Compensation settings usually increase the width of the fill in the direction of the fill to compensate for the process of sewing that generally pulls in the fabric slightly as you sew. The larger your objects, the more pull compensation you need.
 - b. The visual effect of pull compensation is best described in an example. To produce a perfectly round baseball on a shirt –you will probably need to elongate the baseball in the direction of the fill so that the baseball on your computer screen may look tall, skinny and stretched. Funny looking yes, but it will sew far better than a perfectly round computer screen baseball because the digitizer took care of the pull compensation!
3. Regular Fills –these are flat fills and most programs have quite a few selections. The fill is created by the machine walking back and forth in lines at the angle dictated by the digitizer and at the density set by the digitizer.

² Those picture alphabets you sometimes see when perusing the alphabets on your computer.

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Intermediate patterns are created by where the stitches are set, producing either weaves or visible patterns (like scales, hearts or waves). The larger the fill, the more pull compensation and underlay that is necessary to keep it from making your fabric change size. Most allow individual placement of starting and stopping points.

4. Motif Fills –these are fills that are finished with stitches that resemble regular running machine embroidery stitches. They cannot take regular underlay –but don't usually cause as much fabric movement as a regular fill. Many motif fills are used for free standing lace because of their openness they can be layered.
5. Columns –these are fills where the stitches walk back and forth between two defined lines. Angles and width can vary (some programs have angle markers to designate the angle at any given point on the line). Columns can be narrow or wide, but the maximum width for good digitizing is about 12 mm (unless you can put in intermediate stitch points so the individual stitch length is less than 12 mm).
6. Patterned columns (auto columns, fill columns) are a cross between regular fills and columns. They have regular fill stitches instead of the long satin stitches of a regular column. This is a good choice for wider columns or places where you want to add a variable angle for light play (my favorite patterned column use is probably a cat's tail –adds interest and light play and is easier to sew than a regular column).
7. Outlines –Any straight stitch or stitch pattern that is used in a one way object. Outlines don't necessarily have to be on the outside of an object! Most programs have a variety of stitch choices for outlines.
8. Satin Outlines (Stiel Stitches) satin columns that are set to a desired width, rather than set with two lines. These don't vary in width in any given object and the angle is generally perpendicular to the outline object. Most programs will allow you to select the outline width –some even have slight pattern adjustments.
9. Connections, manual stitches, individual stitches –These are virtually indistinguishable from each other and from regular straight stitch outlines, but they are limited to a running stitch or cluster of stitches in a distinct pattern (asterisk like cluster for eyes, or French Knots). They can be used as underlay, outlines, detail lines, connections (between objects of the same color).
10. Special Effects –this is a huge group of specialty fills, rounded fills, contour fills, and radiating fills. With each effect you have a full set of physical limitations you must be aware of or you will have all sorts of issues at the sewing machine.
11. Jumps –places between two colors or between two objects of the same color where there are no regular length stitches that keep the design sewing. Some machines add ties and trims to jumps, some will slow the machine down for jumps to loosen the tension-some don't. Some machines read any stitch over 12 mm as a jump.
12. Stop – a color change, usually is translated into a tie, a trim and a jump as the design is sewn. Stops may or may not be visible in your digitizing software.

What does sewing the design do?

This seems so silly, but sewing the design takes all the stitches that have been programmed and plots them to your fabric, using your embroidery unit as a rather fancy printer. The thing is that with our thread and needle, each time we take a stitch we are piercing and damaging the fabric. Since the thread hangs onto the fabric after the stitch, it pulls the fabric. The fabric has a bit of stretch, especially when the stitches are moving on the bias, so the fabric can stretch and pull as well. Of course, our embroidery unit tries to match where we have put the stitches, but even forces on that can change the movement slightly while it sews –something as simply as a bit of excess fabric hanging off the unit can eventually pull it offline.

And those are the physical forces that limit what we can do while we digitize. We can't put too many stitches in once place, they won't fit –they will either knot up, chain under the work or break the thread. We can't layer too much thread or it will become bulky and catch our needle or feed dogs. We can't create single stitches that are too long –some machines simply won't do it, others will balk but even if they get sewn they are subject to catching on fingers and toes, sagging over each other and not filling in as we hoped they would. There is no advantage to oodles of itty bitty stitches either, they can't be seen as well as longer stitches where the thread has room to lay on top of the fabric and they flatten out are design. If we do too much work in one direction –we will be able to see the effects of that on our design as well.

So, What's the problem?

Foremost is that folks expect the program to autdigitize and get perfect results without having to know anything. That causes some problems and oodles of really bad designs! And tons of frustration (and probably some serious drinking issues as well). If you are going to digitize, you are going to have to LEARN and STUDY –both how your program works and the physics and construction of a design.

Default settings on embroidery programs are usually set to a nice, commercial and professional standard –it may have NO bearing on anything you embroider. It's like a "one size fits all" shirt –probably not the best shirt you own, is it? One

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size doesn't fit all and you'll get better designs if they are tailored to the fabric, thread and usage you envision. Again, you are going to have to take time to LEARN what works and how it works.

The major issues with most designs are easy to categorize:

Too dense –your background shows through? Crank down the density. You don't think the fill is smooth enough?- crank down the density. The design doesn't look right on the computer screen? –crank down the density. You should rarely need to make designs more dense unless you are using thinner thread (50 weight) but this seems to be a novice digitizer's fix for designs when it really just causes more problems.

Too many colors – our graphics use color to show depth of field and slight light variations. When we digitize, we forget that our thread is a great reflector of light and we can get those same shade variations with different angles and fill types – and we tend to reproduce a zillion colors like an artist working with paper and pen does. Here we need to THINK in embroidery –thread-reflection-light.

Too many jumps- when we start digitizing, we don't think about having to move through the design with a single thread and how we can move underneath a fill to another place to begin another object without having to tie off, jump and tie back on. Ties take thread and time and can leave bumps or knots on your work. Most digitizing programs offer all sorts of options for pathing³ your design, but too few folks learn those tools as they are starting to digitize.

Too big or Too small- there are different types of objects and fills and they behave differently, but one of the most common errors is making things either too big or too small. Fills that are too big compile the physical effects of the push-pull of sewing causing gaps or warpage. Details that are too small can just look funny and cause knot or lumps in your embroidery. Scale and the middle of the road are everything in Embroidery.

Too many special effects –most current embroidery programs offer special effects –from curving fills to radiating lines, but just like rick-rack you should use these sparingly. Most special effects bring with them specialized issues for stabilization and underlay and often a special effect can turn a design from awe to awful at the sewing machine in seconds.

Incorrect Underlay –several years ago, many programs didn't offer automatic underlay and underlay was often missing from designs and the issue was simply lack of underlay. The advent of programs that do this automatically has partially rectified this issue, but often there is a better way to do underlay for a give design, but folks simply don't bother to learn how to do it.

Art

This is the easiest part of digitizing, selecting or creating the art that you want to use for your design. Each digitizer will have their own "eye" for design and detail, and this is where it will show up. There are several steps that you will take to analyze the artwork and make some decisions on how it will go together.

Where to find inspiration? Almost anywhere. The list for finding good sources of usable art begins with Clip art collections created specifically for digitizing and then goes to clip art for your computer –there are many large assortments that offer a host of wonderful images ready to go. Add greeting cards, wrapping paper, wall paper, catalogs, photos, books, postcards, old linens, old patterns, dinnerware...you are limited only by your imagination. Don't forget for those who are truly artistic, you can also draw your own images.

Digital cameras are a wonderful source of design inspiration –see a pretty rose? Take a picture and then examine the rose for other details. You really don't have to be able to draw anything to do great designs.

What about copyrights? Keep in mind as you search for inspiration, that there are stringent copyright laws that cover the usage of many images. With copyright free clip art and your own art or photos, you are free from concerns. But with other images you need to be aware that the only free use is personal. If you intend to share or sell either the designs or the items, select images that are either original or copyright free.

Art to Design Template

How to analyze the image. Once you have located the image you wish to use⁴, you need to prepare it for the software that you are digitizing with. The first part of this process is determining how this design will be created and how it will be used –a process often called "mapping". If you like paper and pencil, print a copy of your graphic and make notes as you go along. If you are a bit more into memory-just do it in your head.

³ Pathing is the process of arranging your objects and setting connections and start/end points for your objects to reduce the number of stitches, the knots and increase the underlay potential of your design.

⁴ All designs DO NOT need an image. Modern software often offers elements that can be morphed into other designs and drawing tools you can use to create a design as you draw, don't be afraid if you haven't got an image-you might not need one.

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1. First consider the usage of the final design, including the design size, type of thread, the type of fabric and the type of stabilizer you wish to use.
2. Look at the total image and determine the number of colors in the design. Think of this step as an easy logic puzzle...what will need to sew first so that the overlap doesn't show and the design has a realistic look? What can be sewn at the same time? Which colors can be combined?
3. Decide on angles for the fills and stitch types. Keep in mind with overlapping areas you can digitize a whole furry teddy bear with just one or two colors. If you change the angles of the stitching in various parts (say the head and body at 90 degrees, arms and legs at 45 and 135) the effect of the light will vary on the part and your design will appear when sewn to have 3 or more different colors of thread.
4. Decide on other details, will the design have an outline? Will you use machine stitches to accent it or shade it? What are the most outstanding details of your art and how will you convert that flat art to stitches?
5. Do you want special effects? Specialty threads? Should it match another design? Special effects (such as terry cloth appliquéd to make a really fluffy sheep or clear vinyl added to a design to represent glass) are one way that we can really make outstanding designs. Specialty thread are another way, with fuzzy threads, metallics, holographic threads, color changing or glow in the dark, we can enhance the design and add a bit of specialness that can not be seen on the computer screen. If the design needs to match another design, you will need to keep track of the densities, angles and size, perhaps even digitizing both at the same time to keep them similar enough to match.
6. What is the overall feel of your design image –comical, heirloom, picture book, crewel, babyish, or realistic? All these factors will make a difference in the way that you digitize. For example, black outlines are a common feature in lots of new digitizers work, but they don't even have to be there...they make everything look like it came out of a coloring book and we don't have to digitize that way...think how the design would look with only black accents, or even same color outlines.
7. The last step is to open the artwork at your computer (if it is a clip art, this is easy to do...if not, you will need to know how to scan or use digital photographs) and make a printout of the original artwork. On this printout, list the colors, the order and indicate any special effects and keep this handy as you digitize. This is a Design map and will help you from getting lost during the digitizing procedure.

Correcting the Image While some images will be perfect from the moment that you locate them, others will need to be corrected to work better with the software. You can use the Windows Paint program, a program designed for digitizers, like Loes Predraw, or an art program like Paint Shop Pro. Of course, this will also require a bit of practice with the tools that are available in these programs, and keep in mind that some programs don't really require your artwork be edited at all –if you can open it, crop it or resize it in the digitizing program and you will be manually setting your objects, you are ready without doing anything else.

1. If you are to have an outline, is it clear where it should be?
2. Does the design have the right amount of colors, or too many. In Paint programs, you can delete or change some of the colors.
3. In sections where colors blend, can you “see” how to do it in the software? Do you need to do it or can you blend angles? Can you pick a single color with different textures instead?
4. Simplify if you can, the easier the image is to view, the easier it is to sew out. Many Art programs will let you change the number of colors that show, do a coloring book outline or otherwise enhance the image.
5. Trim away any extra white area around your design. With many of the digitizing programs, your art will need to be exactly as it needs to be displayed in the digitizing software before you bring it into the digitizing program. If your program cannot access and resize or trim the art, this is a good time to do it.
6. Save it in the format preferred by your digitizing program. Most current embroidery programs use .bmp or .jpg but some can use almost anything.

Once the design template is ready to go, you are on your way to having a great design. Your selection and decisions in these steps will help you enormously as you proceed to digitize your design.

Logic

We've already started the process of logical order by analyzing the artwork that we have selected and creating a map of the design. This is just another step in the pre design process. Here we will begin to actually determine which color should go where and why. Once again we will work from our design map, but this time with the image loaded into our digitizing software. Here we are trying to finalize the digitizing order for the easiest sew out. We have our colors; we know what we are going to do where, now we need to figure out WHEN and how.

When digitizing a design, generally you will work from the background or back details toward the front with outlines and small details being sewn last. A secondary rule to keep in mind is large objects to smaller objects. However, there are

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times when this is not necessarily the case. Each design is different and the goal here is to make the design easy to sew out, eliminating jumps and other possible problems during the sew out.

There are lots of designs that are available that lack the logic to make them sew out well. When you are doing a lettering design your movement should be either right down the line of letters, backwards or forwards ...but not jumping hither and yon, then back. Sometimes as you look at a design, you cannot imagine why it was done that way or where it is going next. Good digitizing should be logical, the design shouldn't jump all over and there should be a reason for the order. Especially alarming are designs where part of a fill is completed, then the design jumps to do another fill and then back to finish the first fill...I have digitized like this myself and usually the reason is that the digitizer didn't know how the software worked or didn't care...neither is a good excuse for a poor design. In this case, the split fill often remains split even after the second half is sewn because the pull of the other stitches moved the original fill off line. Even fills that start and stop in the middle can show this effect. Logical design will fill a whole area in one pass and the fill won't have gaps or jumps.

These decisions are based on the individual design and can change from design to design, but generally are a good idea to consider:

1. Which color is to be digitized first?
 - a. Background colors first
 - b. Items that are further back as you look at the design and need to have something else overlapping them (for example a neck-head-hair...neck over head looks bizarre, but head over neck is normal...hair is better on top of head than under it).
 - c. Large areas earlier than smaller areas (large areas can cause more fabric movement).
 - d. From the center of the design to the outside edges...this will help to eliminate gaps and puckering of second and third elements.
 - e. Real life order (clothing on top of body, hair after head).
 - f. Sometimes it really doesn't matter. Aw...how come? Redwork, Some heirloom designs, candlewicking, tiny designs all can pretty much be digitized in whatever order you want. Think about overlap, large areas, trims...and as long as those are under control, you're fine.
2. Are there lots of repeated colors, such as spots, dots, or decorations?
 - a. Can these be digitized BEFORE the background color to eliminate jumps?
 - b. Can larger areas be understitched at once, even though there are different colors on top (light under dark-yes, dark under light-no)?
 - c. Can jumps between areas be taken care of with straight stitching under another color?
 - d. Can jumps between elements be hidden with a few extra straight stitches? You'll find that wrinkles and accent lines can easily be pulled to an outline edge without changing the characteristic of a design (and eliminating the jumps). But some elements (imagine eyebrows) MUST have tie offs and jumps to maintain the characteristics that make them pleasing.
3. Where is the best place for the large fills to start and stop? Is there a benefit from the fill stitching moving either to the left or to the right? Keep in mind the stitching actually pushes the fabric slightly in the direction that it is moving. Do you know how to control the way that your program fills...creating starting and stopping points or do you have to do this manually with connections running underneath to create the proper flow?
4. With separate elements, is there a logical path to follow?
 - a. For flowers, leaves and stems, can you sew the flowers with running stitches between them on the stem line, then the leaves (also with running stitches on the stem line) and finally the stems for a jump free design? Imagine a leaf sewn from the base to the tip...then a jump to the stem...then back down the stem and jump to the next leaf. Now, do it another way. Start at the tip...sew to the base of the leaf...sew down the stem and walk a few stitches out to the tip of the next leaf and repeat the process jump free. Which one would you rather trim?
 - b. Sometimes a small line will not even be visible in the final design and is better than a jump (such as a shirt with a shoulder strap cutting it in two...a straight line of the shirt color on the outside edge of the strap) or a straight line from one element to the other. Professional digitizers often leave elements attached to avoid tiny trims such as lettering with small jumps. If you are not sure whether it works with your design or not, test sew without the jumps and decide by looking at the final version.
 - c. Running stitches in the same or a similar color can be run right across the top of a regular fill or column if you match the angle. They will slip into the fill and live there forever, in their color camouflage.
5. Can you copy and paste? For many designs, you can digitize one element and copy and paste to create other similar elements in your design.
 - a. Flowers, leaves, decorations, outlines, all are easy to copy and paste. Some programs have resizing, rotating and skewing commands that will make them all look different as well.
 - b. Lettering can often be copied and pasted, so you don't need to digitize all the letters

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- c. Design elements can be mirrored and rotated to create the illusion of a varying appearance.
 - d. If your software is an outline format, you can copy and paste then “tweak” the original form to really make things look different. By “tweak” you can make the copy larger, smaller, mirrored, flipped, or - Xpressive users you can even skew⁵ yours!
6. Do you have an extra color that can be conveyed with an angle change or one “used” color over another one?
- a. Good digitizers don’t need to have different colors for each part of a whole (imagine a leaf...you can get a very beautiful look by changing the angle on each side of the center vein and use the same color in a satin stitch for the stem, depth and beauty without extra color changes).
 - b. Large sections can be made more interesting by varying the angle...especially when there are natural lines of change (imagine a teddy bear...he could be filled all in one angle, or you could do the body at 90, the left side arm and leg at 60 and the right side arm and leg at 150, these angle changes give the body a more life like look).
 - c. To make a different color use a very open fill of one color over a more dense fill of another color...a third color in your design, but with only 2 color stops. Requires some manual digitizing (punching⁶) but is well worth the effort.
7. Do you want special threads, overfills⁷, gradient fills⁸ or other special details? Some need to be digitized in a special way.
- a. Overfills can be in the colors of your design or with specialty threads, such as holographic threads, metallics, or color change threads.
 - b. Holographic threads have no tensile strength, so must be digitized with no stitches that overlap a previously sewn area of the same thread, long stitch length (no shorter than 3mm) and special tie off stitches, because if another stitch comes too close to this thread it will cut right through it.
 - c. Metallic threads need a bit of special attention as well. Longer stitch length and special tie offs will help.
 - d. Glow in the Dark and Color Change threads are nice to add, but both are a heavier thread that doesn’t cover as well as regular rayon or polyester embroidery thread does. Keep the density regular (underlay is increased and can be done with regular thread to keep cost down) and regular to longer stitch length.
 - e. Fuzzy threads need extra open densities to fluff up and not just look matted. If you intend to use this type of thread, open up the density and keep the stitch length longer than usual.
 - f. 50 weight threads are useful for heirloom designs. However, they do require that you work with a tight density and a shorter stitch length. The wonderful look and color also lend itself to special details, such as bullion and French knot details.
 - g. Special details include:
 - i. Appliqué (why use all that thread when you can easily create a patch to liven up the design). Also keep in mind that appliqué doesn’t have to be just fabric, think of specialty fabrics (fur, terry cloth, leather, vinyl, plaids...what have you?).
 - ii. Stitch pattern details. Some programs allow you to add regular machine stitches or stitch like patterns to your designs. These can be wonderful, but must be worked in, for example a lacy looking machine stitch as a border for a petticoat, where it looks like a lace edging.
 - iii. The use of clear vinyl for glass, or colored film in an appliqué procedure. (Think fish tank...dark glasses...beer stein).
 - iv. The addition of backgrounds, beads, paint or other non-embroidery details either before or after your digitizing.
8. Outlines can be attached to themselves and worked from various points. Double outlines rarely need to jump!! However, you may have to work with it a little bit. Don’t try to think the whole outline in advance, work piece by piece to get it done one step at a time.
- a. Folds, creases and other outlines can be attached to the exterior outline in most cases for jump free sewing.
 - b. Some outline details aren’t necessary, check you drawing and only use those that really impart detail to the design. When in doubt, leave it out! (Heck, if you don’t like it you can go back and add it later).
 - c. See if you can add a little single line of stitches from one detail to the other that do not need to be trimmed and still look good. You’ll be surprised how often this is possible.

⁵ Some programs allow an image to be skewed by pulling a single corner of the outline, rather than having the whole thing resized at one time. This is a unique feature and great fun to play with.

⁶ Manual punching is the industry term for manual digitizing. It comes from the older commercial machines where the tapes were actually punched to create the design.

⁷ Overfills are created with a solid fill underneath and a second, more open fill of a different color over the top. They add depth and a color change that is marvelous.

⁸ Gradient fills are fills where the density is less than usual so two fills can be intertwined to produce a blended look.

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- d. Some details will need to have a jump. Be sure that there is enough room between them to trim the thread. How? Just jump to an area outside the embroidery, set a single stitch and jump right back in. This look really weird on the computer screen, but when the embroidery is finished and you are trimming, you'll be thankful for the extra thread to pull and trim.
9. Do you have unnecessary stops or color changes?
 - a. Some times we color change more than we need to, for example eyes done in Black-White-Black-White can be more expressive (and much faster sewn out) if they are done Black-Black-White-White and of course then the color stops become Black-White.
 - b. Add elements that are very similar colors into the same color block (unless you really want to have an extra stop for a possible color change later on). For example, a little girl with red shoes, a red hat, and red lips...all the red can be done at once. However, if you use green for the shoes, this won't work will it? Might want to leave a stop for the lips!
 - c. If you do find you have an extra or unnecessary color stop, most programs will let you edit it out quite easily by changing the second one to the color of the other stop that should be the same. It is usually easier to do this than it is to go back and add another one!

Once you have decided where to start and you have some idea of where you are going with the design, it is time to start digitizing. Here is where the last, and probably the most important part of a design comes into play.

Physics

When we are using an embroidery machine, we are taking thread and fabric and exerting physical forces on them as we sew out the designs. This is probably one of the most confusing parts of the process and one that really needs our attention. However, to those with sewing experience it makes lots of sense! As we digitize, we will use our map and the logics we have worked out, combined with our sewing knowledge to create better designs.

The beginning of understanding the physics must be an understanding that while 3D views are fun to look at and give you something of an idea of what your design will look like, they don't show ANY of the real physical factors of sewing. Most 3D views take the lines of your stitches, fatten them up artificially and then shine a light source on this drawing. You can't believe too much about your design based on the 3D view –you'll see things that won't be there when it is sewn and miss errors that will appear in a test sew.

1. The Push-Pull Factors. This is the most common problem when we are taking our digitized designs from the computer and sewing them out on fabric. Our computer screens don't allow for the physical factors that come into play when we are sewing with stretchy thread on equally stretchy fabrics. Not to mention that the amount of effect is varied over the design, depending on where the design is, which way it is angled and whether it is outlined or not.
 - a. Thread sewn on fabric can pull it in (gathering? Of course) if the stitches are long enough.
 - b. Thread sewn on fabric can also stretch it out if the stitches are short enough in comparison to the threads of the fabric (knits, baby weight fabric).
 - c. Thread sewn on the bias of the fabric can stretch it or pull it in.
 - d. The closer your fill is to the bias, the more you will have an effect on the overall shape of the final fill.
 - e. The larger the area of fill, the more the effect of push-pull.
 - f. Compensation settings in automatic programs make the total section larger by the amount you select. Sometimes that will work and sometimes it isn't quite right for the design...think it through.
 - g. Outlines perpendicular to the fill will gap more than outlines that are parallel to the fill. (Plus all the other effects mentioned above).
 - h. Outlines may need to be ON TOP of a fill at the computer to be in the right place in the design.

Well, that's a lot isn't it? However, to negate the effects of this push and pull, you must keep it in mind while you digitize. Imagine you are digitizing a softball and you want it nice and round. You must determine the angle of the fill and elongate the ball slightly in that direction to compensate for the actual pull of the stitches on the fabric. Of course when you do that, your computer no longer will show a nice round ball, but a weird oval shape! Of course, your outline will be closer to the round shape, because the earlier fill actually distorted the fabric slightly back into a round shape. Now, if you are looking at this design on the computer screen you see the oval ball with the outline on top of it and not particularly even...and without a test sew, never know that this is really done right. There is another choice, if you want your ball to be nice and round on the computer screen, you can stabilize it until it is totally immobile and then sew out the design...it will work, but it won't be a pretty as if it is digitized correctly.

2. A foundation of understitching (underlay stitching) is *NECESSARY* for most designs. Just as stay stitching in regular sewing makes the fabric easier to handle, underlay does the same thing for embroidery.

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- a. Most fill areas need some understitching to help negate the effects of push and pull, to keep the fill together and to help the fill be more even and hide possible gaps.
- b. This should run about 90 degrees to the fill.
- c. It isn't going to be seen, so it doesn't have to be perfect.
- d. It can also be from another color, if it is lighter than the top fill and works with the design process. (A striped snake can be digitized with green underlay on the whole snake, then green stripes and finally black stripes, rather than doing both colors of underlay.)
- e. You can actually underlay a whole design made of small pieces with a single color (called a global underlay) to keep the pieces together as well as add the stabilization and color structure.
- f. Edge stitching is underlay that goes right near an edge of the fill. This helps to keep the edge of the fill smooth and even, and can fill slight gaps in the edge.
- g. Satin stitches, column fills and border fills can be enhanced with edge stitching that is straight near the edge of the element.
- h. Fills (both regular and satin) can be padded with either underlay or edge stitching for a fuller look.
- i. Good underlay can let you reduce you density and have a better-looking design that is less bullet proof.
- j. BUT, some of the automatic programs default to an underlay setting that is way too much...check your designs by sewing them out and testing the fills. This is usually true for small areas of fill (which don't need as much underlay as the big ones).

This makes sense, so why is it that so many designs don't have any understitching? It looks funny on the computer screen and it takes an extra step to add unless you have a program that does it automatically. Often designs without understitching are overly dense to compensate for this lack of support, and that doesn't work nearly as well as using a good foundation for your embroidery.

3. Proper densities. Your density should be set according to your design, your thread and your fabric. Most embroidery programs embrace a rather tight density as their default setting. While it might look good on the computer screen, you are certain to have better results if you play and explore different density settings combined with different underlay.
 - a. If you are not getting good coverage of nappy or loopy fabrics, double the UNDERLAY, not the density!
 - b. Adjust small patterns to a greater stitch length rather than increasing the density –the long stitches let the thread plump up and fill the space while smaller stitches get more cramped.
 - c. Try a different angle or a different type of underlay for most issues. For example, a curved column may appear thinner on one side because the stitches are radiating a bit on that side. An underlay edge walk on that side will fill in under the stitches and make them appear fatter.
 - d. Check all samples (especially those with default or tighter densities) to be sure they are not bullet proof. Tightening down the density often results in very tight, cupped sections of embroidery.
4. Overlap of areas. This is one place where stitch-by-stitch digitizers and those who use programs where areas need to be defined have an advantage over most automatic digitizing programs, in that we can select to overlap areas of our design.
 - a. Overlapping areas of the same color allow you to meld angles of fills or adjacent areas without having breaks between the sections.
 - b. Overlapping will eliminate and reduce gaps between sections.
 - c. Overlapping can give you a much clearer 3-D effect in realistic designs.
 - d. The under (or sewn first) part of an overlap doesn't need to have an edge that matches the overlapping part. All you need to do is to keep in mind the contours of your final fill and set your outline accordingly.
 - e. An overall compensation setting in an automatic program will enlarge the whole section by that amount. Sometimes that is fine and other times, what you really need to do is to just have one area of the section larger...so if you use this, check it to see if it does what you really want it to.

As you can guess, overlapping sections of your design just make it that much more stable, give it a better look and let you have a little error without a little gap. It takes a while to get a feel for how much overlap you will need, but with a little practice, you'll get a feel for it. Keep in mind the physical factors of the digitizing as well as the logical ones and don't be afraid to test and experiment.

5. Details on top or in a hole? This is a question that comes up all the time when you are digitizing. Should you create a fill with a hole to accommodate the details or are you better off digitizing them on top of the other fill...and what is the difference?
 - a. Tiny details should be set on top of the other fill, and with an angle of 90 degrees different than the fill. If 90 degrees isn't possible, then try to add understitching that will keep the details from falling between the base fill stitching.

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- b. Large details can be worked from a hole in the base fill. This saves thread and time and lets you select any angle for the fill as well. Decide before you start whether you want to do the details first, walking stitches between the sections and then set the final fill over the top or do the details later with jump stitches.
 - c. If you are using a very light detail on a very dark base fill, leave yourself a hole to work with as sometimes it is hard to cover dark thread with light and get it to look right.
6. Proper stitch length. This is important for both embroidery and washing and wearing concerns.
- a. Fill stitch lengths that are too short can stretch the fabric and cause chaining⁹ underneath the work. 2mm is about the shortest stitch length you should use for a fill, you can use short lengths of 1.5 for outlining IF YOU MUST!
 - b. Fill stitch lengths that are too long can cause the fabric to gather or cause problems with catching and snagging during wear. 4mm is the default for most fills.
 - c. Satin stitch lengths can cause even more problems.
 - i. Too short, satin look is lost (2mm is about minimum for a good look). If you must go narrower, slant the stitch angle so your narrow column has longer stitches.
 - ii. Too long can cause tunneling of the fabric (6-7mm is about the maximum although most programs and machines will do up to about 12mm...don't use this without TONS of support stitching underneath, unless you want gathered fabric).
 - iii. Too long can also slow down the sewing speed of the machine. If the machine doesn't slow down for these long stitches, the fabric will tunnel or the thread will be stretched to capacity or else the thread or the needle will break.
 - iv. Some embroidery machines cannot even sew out long satin stitches so be sure to check these for proper length. Some of the software won't even create stitches for these areas that are too long...if you see a blank place instead of stitches in your design be warned it may be because you have forgotten this rule.
 - d. Jump stitches shouldn't either be too long or too short. Less than 2mm between elements in a design, and it is just too hard to trim.¹⁰ But very long jump stitches slow down the machine and cause both needle and thread breakage.
 - e. Outline stitches should be moderate in length as well. Between 2-4mm is a fairly good length for them. Smaller than 2mm and your thread may not show up as well, longer and you may lose curves and other details. For really curvy places in outlines, you can take it down to 1-2mm...but just in the curvy places.
 - f. Some automatic programs do a double outline by reversing back on their own path. For example a circle is outlined by going around in the clockwise direction to 12, then reversing and going counter clockwise back to 12 on the other side. While this is all right, it can leave a small gap at the top of the circle (where it turned around and our physical thread pulled the fabric slightly). If you are manually digitizing this, the fix is to just duplicate the first fill and go around 2 times the same way. If you are using a more automatic program, you might want to add a stitch or two to be sure that the very top is closed.
 - g. Watch for outline or detail stitches that go the same direction as fill or other stitches. When two lines of stitching wind up right on top of each other, it is possible for the second one to actually slide down underneath the first or for the stitches to become intertwined. This will affect the way the details or outline look. For example, eyes filled with the same direction of fill as the face may be smaller and meaner looking with a ragged looking edge. Turn the fill 90 degrees or add a line of support stitching underneath the edges of the eye and the exact same digitizing will look great and pop out of the face.
 - h. Watch for errant stitches that are too long during your test sew outs. Most digitizing programs periodically add a long stitch, in with the fill stitches that really should be sewn just like the fill. When you find one of these, go back into the design program and change the length to match the fill.
7. Fabric enhancements. Some fabrics (felt, denim, and cotton duck) are very forgiving and designs sewn on them look wonderful without much special care. Other fabrics require special digitizing to sew out perfectly every time.
- a. Knits like a fairly loose density with nice close understitching for the best cover. Keep outlines about 2.5mm and be sure to add understitching and edge stitching to any satin stitch outlines.
 - b. Terry cloth or loopy fabrics really need extra understitching to control the loops. Also for this type of design you might want to add more bold details and less open stitching so they don't get lost in the loops.

⁹ Chaining is when several stitches are in exactly the same place and force the fabric (or the extra stitches) down under the work, causing a "chain" that then can snag on the feed dog area of the sewing machine.

¹⁰ Use a trim stitch, which is a stitch pulled to the outside of the design between these types of elements. It is easier to trim. This looks really funny on the computer screen, though.

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- c. Lightweight batiste and other heirloom fabrics really like a light touch with the digitizing as well. Keep the stitches short (2-3mm) the fills small and be sure to have enough understitching to keep the fabric from gathering.
 - d. Baby knits need a really loose density and very small design to be sewn out perfectly. Try to use both an edge stitch and an understitch for sections that need extra depth.
8. Tie on and Tie offs. Funny as it sounds, this can make the difference between a good design and a bad design. While the home machines are not as susceptible to huge problems from this as commercial machines are, it is good digitizing to include these on all your designs. When a design is not properly tied on, your thread can start to unravel or not catch at all as the fill begins. If it is not tied off properly, your design can unravel or you can get threads that must be hand pulled to the wrong side and manually tied off or glued.
- a. Tie ons should be underneath the fill or near an inner detail edges and at least a triangle or even a star or square of stitches that are about 1mm apart.
 - b. Tie offs should be slightly on top of the fill (where the trimmed thread won't look all fuzzy on the edge of the design). Tie offs are more substantial than tie ons, with either a crossed square or a star of 1mm stitches. Some programs have a varieties of ties to choose from, some do not.
 - c. When you can place tie off and tie ons in places that are not edges of the design...boring places where no one will see them. It will give your design a more professional look. To do this, remember you can add a line of running stitches right down the middle of a fill if you match the stitch length or pattern that is already there and it will not be seen...and thereby have a better place to do your tie off.

The Final Test

The last step in digitizing is testing and retesting your design. Test any fill you have questions about, test special effects and test your outlines. It is fairly easy with most of the newer machines to quickly send a design to the machine and run a test sew out of either a part or the whole thing. Before you sew on your good fabric, a complete test sew out is also in order. Keep your design map close by and jot down any places where you see room for improvement or places that need to be fixed. If you are planning on selling designs, be sure to have someone else test them as well!

Of course, the proof is in the test so to speak and once digitized, a good design will make you happy and pleased when you sew it out. Bad designs will be readily apparent as well...and I should add there is a third category...I like to call them "HUH?" designs...sort of good, but something weird happens along the way. Usually, these can be fixed quite quickly and changed into good designs.

So, now you have a good idea about the three basic principles of digitizing. The first is artistic concept (where we select the design and analyze it) the second is logic (so the design sews out properly and is easy to understand) and third is the physics (so the design looks like we want it to and so our fabric is not damaged during sewout). All these concepts lead to designs that are easy to sew, not in need of bullet proof stabilizing and items that will wear and wash well.

Of course, we also must mention that although these are good guidelines for producing better-digitized designs, there are exceptions to everything (almost everything, don't sew over the top of Sliver...it will still shred). Sometimes you need to do things a bit differently than the average to produce a truly remarkable design. The key here is to use common sense, practice the principles and experiment to your heart's content. Keep in mind there is no substitute for a test of any design or part of a design that you are working on to find out if it will really do what you want to.

Happy Digitizing!!