DA'S VECTOR

Tutorial

Contents

Introduction

This tutorial follows two goals: First of all it is meant to introduce the newcomer to the field of (vectorial, Bézier-oriented) computer graphics, working step by step with DA's VECTOR. This doesn't mean that the functions are explained again (you will find that all the required function descriptions are in the reference handbook), but you will learn to work with DA's VECTOR by carrying out simple exercises. Naturally we cannot aspire to completeness — the program is far too big and complex for this. In choosing the exercises we have been led by two criteria: first we wanted to answer general queries that have been raised repeatedly with our support service (e.g. about the tracer), and secondly we wanted to show the more hidden features, which only open up when one knows what one can actually do with the individual functions. So while you will not find in the program an explicit function to create colour graduated tints, nevertheless colour graduated tints may be generated and used in numerous ways if one knows how to do it. And here things become interesting also for many professional users, since some of the exercises show at least the principles of really ambitious tasks such as the construction of real-looking shadows or some lithographic applications. We hope that with this we have also come near to our second goal, namely to show the professional user suggested solutions capable of extension, even to very difficult problems.

The organisation of various parts of this tutorial also corresponds to this. One can work through it as a continuous course, one can limit oneself first to elementary exercises for beginners or transfer at once to the more advanced exercises for the experienced computer graphic user. Alternatively one can orient oneself on the index of the exercises and KNOWHOW chapters and just pick out those things that are of interest. Please do not be surprised therefore if the same exercises appear under different headings; the various lists are only intended to support different procedures. Besides the division into exercises for beginners and advanced users you will also find throughout subdivision into EXERCISES and KNOWHOW chapters that are meant to convey background knowledge and experience.

A tip for the practical use of this tutorial, above all for use during exercises. Leave the KNOWHOW window lying open on the desktop while working through the exercise, specially if you are working with high screen resolutions. You can position the window at the bottom edge of the screen, for instance, and so have the complete run down of the exercise available directly.

Well, it only remains for us to wish you much enjoyment and success in working with DA's VECTOR and this tutorial. Learn it quickly, because DA's VECTOR PRO is almost complete and then there will be a lot of new things to be learned.

What can be traced?

Most of the telephone calls to our support service concerned the tracer. We formed the impression that many users were not clear what a tracer of this kind was capable of. One thing should be made clear from the beginning: It is not possible to convert normal colour or halftone photographs automatically into vector graphics, thus creating quasi 'vectorised photographs'!

Essentially, a tracer has the task of producing outlines from shapes in a (usually scanned) source picture. These shapes must be recognisable or identifiable is some way (as for the human eye). In seeing, the distinguishing mark of a shape is a boundary that encloses a more or less uniform (constant colour, constant brightness) region. The eye orientates itself mainly on steps in brightness; colour differences are less important. Hence a halftone picture often suffices as a source — even for a coloured vector graphic. Furthermore, setting of colour thresholds is more difficult than the setting of brightness (grey-step) thresholds.

The tracer in DA's VECTOR has one peculiarity: It works exclusively with colour and halftone pictures. Line pictures (monochrome bit images) must first be converted to halftones (with DA's CONVERTER). However, following many user requests we will build the ability to trace monochrome pictures directly into DA's VECTOR PRO.

Sacrificing monochrome picture handling had a good reason: The complicated mathematical optimisation of the tracer could be dropped and replaced by simple and intuitive adjustment by means of colour selection. However many users had problems with just this point, based partly on poor understanding of the properties of scanned pictures. Hence some introductory theory before we start with the exercises.

Natural surfaces never have a completely uniform colour (or uniform brightness). Every natural body possesses a surface structure, which when viewed blends with the colour into a single impression. For this reason alone a scanning process will never produce a completely uniform colour area. To this is added a second problem: Each scanner has some 'inherent noise', which means that a given colour (or brightness) is not read in exactly as such, but has random fluctuations superimposed on it (one can reckon on 5% to 10%, depending on the scanner), and due to manufacturing limitations the sensitivity of individual CCD reading cells is not completely identical (risk of stripes).

A further problem arises if one scans in printed source material. Usually the result is an interference 'beat' (moiré,) with the printing raster or screen. If possible one should avoid working with such source material, but sometimes this cannot be avoided. All such interference, structure variations etc. make the tracer's work harder, which after all is supposed to draw around the boundaries of coherent colour - or brightness - regions. You can compensate for this either by a skilful choice of the colour thresholds (see below) or by modifying the picture first in a suitable graphics program: Reduce the number of colours, soften or smudge etc.

EXERCISE: Vectorising halftone graphics - A simple basic exercise
TASK: This exercise deals with understanding the principle of the tracer, and to try this out on a simple halftone (grey scale) picture. We will generate this grey scale picture ourselves from a vector graphic.

STEP 1: In the 'Vector Graphic' menu import the 'COMIC1.HTV' object and position it on the work surface. Now select the object.

STEP 2: Under 'File' select the 'Print' menu entry. An 'Output Settings' dialogue appears. Click on the field next to 'Driver' and select 'TIFF GrayBlock (File *.TIH)' in the following dialogue. Set a resolution of 127 or 150 dpi and activate the field: 'Adjust: To Graphic'. If you now click on 'Print' you can create a halftone picture file with a name of your choice.

STEP 3: Go into the 'Vectorisation' menu. Import the halftone picture that you created earlier.

STEP 4: Your task consists of the following: Try to recover from this picture the original graphic (in grey scale, not in colour). For this, you have to trace the variously toned grey areas one after another. The task can be described as simple since you only have a few, precisely defined single-tone grey areas.

You can pick each tone value of an area from the picture, both as the lower and the upper threshold, since they are identical in this simple case. Before you select the tracer in the Bézier mode, you should set the same colour (threshold value) in the 'Area Attributes' sub menu; then the vectorised areas will be created directly in the correct grey values.

STEP 5: In the original there are also black lines between the colour areas from which the figure is constructed. You can restore these lines in two ways: you may either trace them as black areas, or you may add to all vectorised areas a (thick) black outline.

RESULT: You have recovered a vector graphic from a picture original more or less successfully. You can achieve greater accuracy by, for instance, generating the picture in a higher resolution. The picture will then, of course, need more storage space (on the hard disk) and the vectorisation will take somewhat longer. This test is, of course, somewhat unrealistic since the picture was not scanned in, but created artificially, and therefore did not incorporate any noise (random density variations). For just that reason the exercise illustrates the principle of the tracer in a simple manner.

EXERCISE: Snapshot of picture objects

TASK: Often you just need a photograph in your graphic. DA's VECTOR does not handle photographs (halftone or colour pictures) as individual objects, but only as fill patterns for objects. You now have to create a rectangular frame of suitable proportions and provide it with the desired photograph as a fill pattern. This is much easier to do with the tracer menu.

STEP 1: Go into the tracer menu by selecting 'Vectorisation' in the 'Edit' drop-down menu or by pressing the 'F1' key.

STEP 2: Import the desired photograph (halftone = TIH or colour = TIC). If you do not have pictures to hand in these formats then use one of the fill patterns.

STEP 3: Click once on the 'Create picture object' icon. It will appear inverted for an instant.

STEP 4: Go into the 'Vector Graphic' menu. The working area will now contain a rectangular frame with the photograph as contents (fill pattern).

STEP 5: Select the 'Area Attributes' sub menu. Select the picture object and select the 'Rel' option to be active. Switch off the 'Fix' option.

RESULT: You will now have a freely movable and scalable 'Picture object'. In the 'Line Attributes' sub menu you can still choose the properties of the surrounding line, or switch this to be invisible.

EXERCISE: Vectorising colour graphics - A simple basic exercise
TASK: This exercise deals with understanding the principle of the tracer, and to try this out on a simple colour picture. We will generate this colour picture ourselves from a vector graphic.

STEP 1: In the 'Vector Graphic' menu import the 'COMIC1.HTV' object and position it on the work surface. Now select the object.

STEP 2: Under 'File' select the 'Print' menu entry. An 'Output Settings' dialogue appears. Click on the field next to 'Driver' and select 'TIFF GrayBlock (File *.TIH)' in the following dialogue. Set a resolution of 127 or 150 dpi and activate the field: 'Adjust: To Graphic'. If you now click on 'Print' you can create a halftone picture file with a name of your choice.

STEP 3: Go into the 'Vectorisation' menu. Import the colour picture that you created earlier.

STEP 4: Your task consists of the following: Try to recover from this picture the original graphic with the same colours. For this you have to trace the variously coloured areas one after another. The task can be described as simple since you only have a few, precisely defined single-coloured areas. You can pick each colour value of an area, from the picture as both the lower as well as the upper threshold, since they are identical in this simple case. Before you select the tracer in the Bézier mode, you should set the same colour (threshold value) in the 'Area Attributes' sub menu; then the vectorised areas will be created directly in the correct colours.

STEP 5: In the original there are also black lines between the colour areas from which the figure is constructed. You can restore these lines in two ways: On the one hand you can trace them as black areas, on the other hand you can add to all vectorised areas a (thick) black outline.

RESULT: You have recovered a vector graphic from a picture original more or less successfully. You can achieve greater accuracy by, for instance generating the picture in a higher resolution. The picture will then, of course, need more storage space (on the hard disk) and the vectorisation will take somewhat longer. This test is, of course, somewhat unrealistic since the picture was not scanned in but created artificially, and therefore did not incorporate any noise (random density variations). For just that reason the exercise illustrates the principle of the tracer in a simple manner.

EXERCISE: Tracing a 'noisy' picture

TASK: This exercise deals with understanding the principle of setting colour threshold values, and to try this out on a simple colour picture. We will generate this colour picture ourselves from a vector graphic and will additionally superimpose some noise on it so as to make it similar to a natural, scanned-in original.

STEP 1: In the 'Vector Graphic' menu import the 'COMIC1.HTV' object and position it on the work surface. Now select the object.

STEP 2: Under 'File' select the 'Print' menu entry. An 'Output Settings' dialogue appears. Click on the field next to 'Driver' and select 'TIFF GrayBlock (File *.TIH)' in the following dialogue. Set a resolution of 127 or 150 dpi and activate the field: 'Adjust: To Graphic'. If you now click on 'Print' you can create a halftone picture file with a name of your choice.

STEP 3: In the 'File' menu select the 'Services' menu entry and in that select the 'Add noise to colour pictures' accessory program. A file selector appears in which you now choose the previously created colour picture as a source picture, and type in a new destination picture. In the following dialogue choose the 'Coarse' noise option.

STEP 4: Go into the 'Vectorisation' menu. Import the colour picture that you created and added noise to earlier.

STEP 5: Your task consists of the following: Try to recover from this picture the original graphic with the same colours. For this you have to trace the variously coloured areas one after another. But due to the presence of random noise the areas no longer consist of a single colour but show quite wide colour variations, similar to those obtained from a scanned picture. If you try to pick the colour value of an area from the picture a number of times, you will get a different (though similar) value at every attempt. Your task consists of finding limiting values (upper and lower colour thresholds) for each colour area that include all of the local colours, so that the colour area can be traced as a continuous shape. That is not at all easy: Just try to pick the lightest and darkest colour from the picture — almost a fruitless enterprise. And if you are not completely successful the tracer will divide the area into small sub-areas down to the size of a pixel. The best thing is to look for a median (intermediate) colour value and at the same time select both thresholds (SHIFT + click on the 'Pick' icon) with an appropriate percentage spread value. With the 'Coarse' noise in this picture you should look for a setting of some ñ6 - 10%. As a check, here are the 'correct' values for the hair of the comic figure:

C:	44 - 75
M:	123 - 154
Y:	239 - 255

These are the exact limits that were measured with a colour picture editing (retouching) program. You cannot work that exactly by picking colours; that is why you should, if possible, select as large a 'spread value' as you can. Before you select the tracer in the Bézier mode, you should set an intermediate colour (between the threshold values) in the 'Area Attributes' sub menu; then the vectorised areas will be created directly in the correct colours.

STEP 6: In the original there are also black lines between the colour areas from which the figure is constructed. You can restore these lines in two ways: On the one hand you can trace them as black areas (noise also has to be considered here), on the other hand you can add to all vectorised areas a (thick) black outline.

RESULT: You have recovered a vector graphic from a noisy picture original more or less successfully. For this you had to compensate for artificially created noise by a suitable choice of the threshold values. In this respect this task is similar to tracing shapes from scanned-in pictures, where however further problems may emerge (highlights and shadows, surface structures, scanner noise, edges which are not sharp).

EXERCISE: Path optimisation in tracing via colour thresholds
TASK: To generate a vector graphic with the highest possible quality (faithfulness to form) from a letter (S) scanned from a newspaper advert. Here we are dealing on the one hand with a simple shape on a clearly contrasted background, which simplifies the task, but on the other hand typical problems with scanned

pictures (noise, not sharpened) and also screen moirés have to be taken into consideration. Despite the simplicity we are thus dealing with a realistic exercise, that may be met any day as a practical task.

STEP 1: In the 'Vectorisation' menu import the 'TRACE_S.TIH' halftone picture.

STEP 2: Now take a look at the halftone picture at a high magnification, specially the edges of the letter. You will see how blurred the picture is that the scanner has captured (which is also partly the result of a poor and small original). This unsharpness is also present in a monochrome ('line') scan of the original, though there as a (real information-) loss of shape accuracy.

STEP 3: In the 'Area Attributes' sub menu select the 'Transparent' option. Go into the 'Line Attributes' sub menu and there select '0' as the line weight (hairline!). Select black for the line colour.

STEP 4: Now trace the picture with a lower threshold value of 192 (the upper threshold remains at 255 for the whole exercise). Repeat this with threshold values of 160, 128 and 96, where you PREVIOUSLY alter the line colour to red, green and blue respectively.

STEP 5: Select the 'Vector Graphic' menu. You will find four superimposed variants of the 'S' in different colours. Now you can study the effect of the different threshold value settings on the resulting shape. Choose a large magnification for this. Look above all at the two end-points of the letter and the problems of recognising corners that occur there. Take another look in the tracer menu, perhaps, at the corresponding portions of the original picture: The 'dirty' corners are already discernible there. By picking a suitable threshold value one can overcome this inaccuracy (locally) and thus improve the recognition of the corners.

RESULT: You have vectorised a shape scanned as a halftone picture with different threshold values, and from the results have experienced visually the significance of these settings. You can extend this exercise further yourself by experimenting with further tone values that you pick from the picture at critical points.

EXERCISE: Trace vectorial freestanding shapes
TASK: In this exercise you will learn how the tracer can create a vectorial mask or a vectorial freestanding shape in any desired part of a picture. As compared to

a real task the exercise is simplified since the colour picture (created by you from a vector graphic) does not incorporate noise and the shape itself already stands on a white background (free). In essence the principal procedure is to be demonstrated and the quite complex problem of positioning fill patterns is to be explained.

STEP 1: In the 'Vector Graphic' menu import the 'COMIC1.HTV' object and position it on the work surface. Now select the object.

STEP 2: Under 'File' select the 'Print' menu entry. An 'Output Settings' dialogue appears. Click on the field next to 'Driver' and select 'TIFF GrayBlock (File *.TIH)' in the following dialogue. Set a resolution of 127 or 150 dpi and activate the field: 'Adjust: To Graphic'. If you now click on 'Print' you can create a halftone picture file with a name of your choice.

STEP 3: Go into the 'Vectorisation' menu. Import the colour picture that you created earlier.

STEP 4: Set the lower and the upper threshold values as 0 in all colour areas. (TIP: Pick the white colour from the background of the picture). In the 'Area Attributes' sub menu first choose black as the fill colour and in the 'Line Attributes' sub menu the 'Transparent' option. Now start the tracer in Bézier mode.

STEP 5: Go into the 'Vector Graphic' menu. Select the object you have just generated and dissolve the group. Throw the internal portions (at the eyes and at the elbow) where the tracer has only found white into the trashcan, so that only one path object remains. This object consists of a frame around the whole picture and the outline of the figure. This appears as a black area with the figure left clear and transparent (if not, you must use the Vector Path Editor to reverse the rotation direction of the outer path).

STEP 6: Select the object and go into the Vector Path Editor. You will clearly recognised both parts of the graphic: The surround frame and the outline of the figure. Select the scissors icon ('Cut open paths') and cut through the middle of all surround lines of the rectangle. Now change over to the 'Edit Vector Path' tool. Also switch on 'Snap to curve control points'. Next, move the path points at each cut (simple with snap on!) to the nearest corner so that finally all that remains are superimposed points at the four corners, but no line portions.

STEP 7: Return to the Vector Graphic Editor. Now the figure will appear black on a transparent background, as if cut out with scissors ('free'). Select the object and in the 'Area Attributes' sub menu select the just-vectorised picture as a fill pattern (switch on 'Rel' and switch off 'Fix'). Now the figure portion of the picture will appear correctly positioned inside the path. The whole object can now also be moved and scaled without losing the fixed relationship between path and fill pattern position or size.

RESULT: You have produced a vectorial freestanding shape or a vectorial picture mask with the aid of the tracer on a simple example and at the same time created a freestanding (masked) picture object, and with this achieved a quite complex lithographic task. In real life the task is rendered more difficult due to noisy pictures, unsharpness and more complex backgrounds. By fixing the object frame to invisible corner- points (reduced picture frame) we achieved exact positioning of the fill pattern relative to the outline shape. Through suitable selection of the fill pattern attributes this arrangement remains stable during movement and scaling.

Tracing Manual Sketches

No computer and no software, least of all input tools such as the mouse or digitising tablet, can replace working with pencil and brush on paper during the creative design phase. Thus the question often arises: How do I get my design sketch into the computer? Does this graphic have to be 'rebuilt' completely in the computer, or can this process be automated at least in part? In many cases scanning in the drawing followed by its vectorisation can help here. But you should note a number points: The best vectorisation occurs with unambiguously recognisable colour areas. Originals with clear, opaque colours are best suited for subsequent Vectorising. Glazed colours produce many intermediate steps (layer on layer) or transitions and graduations (wet in wet) that is much more difficult to convert. The same applies to areas covered with coloured pencils or crayons, where often 'rough' surfaces with a pronounced material structure (paper structure etc.) produce white gaps in the applied colour that the tracer finds hard to recognise as a connected colour area. Interesting possibilities arise when one uses the fill pattern functions of DA's VECTOR: The scanned-in sketch then serves not only as an original for the shapes to be generated in the computer, but the scanned colour surfaces can themselves be used as fill patterns: In this way one can achieve the characteristic style of 'handwork' in a computer-generated graphic. The bundled fill pattern library contains a simple example of this: The 'STRUCT04.TIP' fill pattern was achieved by scanning a colour area which had been created earlier with wax crayons on white paper. The scanned picture was modified in a picture editing (retouching) program (mirrored upwards and downwards, reduced to 256 colours) and serves as a simple example for 'handmade' natural structures.

EXERCISE: The highest art: Tracing by hand

TASK: As long as you have a little experience you can always 'trace' better than any vectoriser. The trained human eye and practised hand cannot be surpassed by any (computerised) tracer in the world. However desirable automatic vectorisation may be, in many cases only 'manual tracing' or at least manual after-treatment (tidying up) of vectorised originals will give optimum results. This exercise therefore consists of two parts: First you are to tidy up the bundled 'TRACE_S.TIH' picture by hand, and second 'recreate' it completely manually.

STEP 1: Go into the 'Vectorisation' menu and import the 'TRACE_S.TIH' halftone picture.

STEP 2: In the 'Area Attributes' sub menu select black as the colour. Go into the 'Line Attributes' sub menu and there set 'Transparent' as a line attribute.

STEP 3: Now trace the picture in Bézier mode with the lower threshold value at 128 (the upper threshold remains at 255 during the whole exercise).

STEP 4: Go back to the Vector Graphic Editor and select the object. Now go to the Vector Path Editor and switch on the background picture. Try to correct the traced shape on top of the original as much as possible with reshaping, adding intermediate points (e.g. at difficult 'corners') etc.

STEP 5: Store the object in the clipboard and try to build up he whole shape manually with Bézier curves. For this the correct choice of 'control points' is important: With a little practice you will soon find out the best places to start or end path segments (Bézier curves or lines).

RESULT: You have practised on a simple example how to tidy up a shape produced by the vectoriser and also how to 'recreate' this shape manually. A combination of automatic vectorisation and manual tidying up helps you achieve the best quality. Skill and practice though are essential for this. Even on a computer you get nothing for free!

Generating Vector Graphics From Photographs

It has already been said elsewhere, but (from the experience of our support service) cannot be repeated too often: No vectoriser is capable of automatically generating from a colour photograph a vector graphic that looks 'photographic'. A photograph (scanned colour picture) is always something different from a vector graphic (graphic made up of shape outlines). But there are some interesting transitions and a broad field of study for 'playing around creatively' for which the following references should serve. One can achieve (mostly unforeseen!) interesting graphical effects or generate shapes that on the one hand are similar to the photograph but on the other hand show the typical stylisation, alienation and shape elements of a vector graphic.

If you wish to experiment with such 'vector photographs' you will also need, besides DA's VECTOR, a picture editing or retouching program since the scanned photographs (colour or halftone) have to be prepared for the vectorisation process. Since at the time this tutorial was prepared DA's PICTURE was not yet available, we have used DA's REPRO CD for the pre-treatment. In principle, of course, any other picture editing or retouching program is suitable for pre-treating the pictures, but if only for the compatibility of the file formats and the professional features DA's REPRO CD is the best tool for such tasks at present.

Let us start with halftone pictures first. It is much easier to generate vector graphics from these than from colour pictures (due to their three independent 'colour channels'). Since you can 'ink in' the resultant vector areas in any way you like, it is often easy to add colour afterwards.

The goal of the preparation process consists essentially in simplifying and smoothing the shapes, and reducing the number of grey values (colours). Once you have endured your first experience of 'endless tracing of individual pixels', you will easily understand the points that matter. In principle you will create the complete graphic in the picture editing program; the tracer only serves to convert this graphic into vector areas.

How can one smooth colour or halftone areas? First of all the noise has to be removed. At the same time adjacent colours (grey values) should be averaged. Both of these may be achieved by local softening or smudging if one makes the threshold small enough: Then only similar colours will be averaged of smudged, whereas sharp borders (jumps in grey value, contours) will be retained unchanged. The threshold should be suited to the number of grey tones that will be required finally. In a reduction to 8 grey steps, therefore, a threshold value of 32 is recommended.

An important task is the weighting of the grey tones across the gradation scale BEFORE the reduction in the number of steps, since this determines in advance which grey tones will later blend together to form one area. (DA's REPRO CD can, for instance, suit the grey-scale distribution in the picture to the information content and thus achieve extreme contrast improvements). At the end you reduce the number of grey values to 4, 8 or 16 — depending on the picture. These grey steps should not show any interleaved 'fringing' anywhere, but form the smoothest possible contours. Here some experimentation may be necessary!

Finally you then trace the remaining grey tones in DA's VECTOR. For this you have principally two possibilities for setting the threshold values (though mostly only with grey levels, not with colours!): Mutually exclusive areas can be traced with an exact threshold value (lower threshold = upper threshold = area tone value), or mutually overlapping areas with an increasing upper threshold (e.g. 0 - 31, 0 - 63, 0 - 95, 0 - 127, 0 - 159, 0 - 191, 0 - 223 and 0 - 255 = whole picture). These area objects are then superimposed in reverse order. The second procedure has the advantage that any inaccuracies in the vectorisation process do not lead to white flashes between the colour areas; a black area will be placed at the bottom, then a dark grey will be placed over that, then the next lighter area etc. up to white or light grey.

In principle this can be done with colours as well, but is far more difficult. Very helpful here are functions that greatly reduce the number of colours that appear in the picture but nevertheless retain a high colour fidelity. We are still developing appropriate special functions for reducing a picture to any desired number of 'optimum' colours. DA's REPRO CD however already offers the possibility of recalculating a TrueColor picture to 256 and then 128 optimum colours. In combination with other measures that have already been described for halftone pictures (softening and smoothing, gradation adaptation, binary reduction of the individual colour portions to 2 - 8 colours) one can calculate colour pictures down to some 16 - 32 different colours. This however requires a lot of trial and error and subtle intuition.

Naturally you can also produce many quite different picture manipulations with the functions provided in a high grade picture editing program, such as false colour reproduction, contour calculations etc. It depends only on the picture in question and your creative intentions what the end result will be and whether it can be transformed into an impressive vector graphic.

For colour pictures the individual remaining colours must be traced separately (lower = upper threshold = colour value) and assembled into one another. Manual correction is virtually unavoidable for this to prevent white flashes. Alternatively you can also surround all areas with a line of the same colour in order to compensate for the inaccuracies.

As already noted at the beginning: We are dealing here with an amply experimental field, which clearly hinges on the preparation (in the picture editing/ retouching program) DA's VECTOR and DA's PICTURE will naturally complement each other in this respect very well.

Vector Graphics Backwards - Learning Through Analysis

If you are a newcomer to (Bézier-oriented) vector graphic programs, then you will naturally have a number of things to learn. In the same way as handling a pencil and brush can be learned, so too can use of a computer as a graphical tool. It is almost impossible to give general directions here. But we would like to reveal a small trick here which will certainly make your entry to this field easier: Take the supplied examples (you will find others in our support mailbox) or examples from any desired clip-art collection and TAKE THESE APART: First dissolve the groups and pull these apart — in other words quasi dissect the graphic into individual parts right down to the individual path objects. In this way you will get an idea how the graphic was constructed. Then simply try the reverse process: Build up the finished graphic anew. Such exercises, based on the experiences and results of others, form a really simple way of learning the 'construction' or 'drawing' of vector graphics.

Colour Graduated Tints

Vector graphics with single-toned colour areas easily look artificial and 'constructed'. If one wants to reproduce natural objects with their light and shade graduations, then colour graduated tints in place of single-toned colour areas appear much more lifelike and natural. In addition, areas with colour graduated tints often find favour as simple style elements.

Colour graduated tints are mostly realised as adjacent vector areas with increasing or decreasing colour shades. Depending on the graduation (colour limits) only a limited number of intermediate steps will be created, that some programs (most probably for storage and speed reasons) will further artificially limit (say to 64 graduation steps). In general such colour graduated tints are not usable for printing out, since they will almost always look 'stepped' thus losing the character of a graduation. This is a very odd effect, as in a graduation (or, rather: at every colour boundary) human vision can suddenly detect differences that 'actually' shouldn't be visible at all, since the human eye is believed to be capable of differentiating only some 60 colour steps (per basic colour, or with halftones). If one thus creates a grey scale or colour graduated tint with 256 steps, the human eye should no longer be able to recognise the steps / borders. But just at such borders the sight mechanism creates an increase in local contrast that makes the border visible as such. So however much one exerts oneself, vectorial graduated tints at high resolution (i.e. above all during printout) will always appear stepped. Don't be fooled by the appearance on the screen, it's guaranteed to look different in print!

DA's VECTOR at present offers no DIRECT functions for producing (vectorial) colour graduated tints (however that will be changed in DA's Vector Pro!). There are three reasons for this: Firstly in many cases we find vectorial colour graduated tints to be unusable (see above); secondly there are a number of powerful functions in DA's VECTOR with which crafty colour graduated tints can be generated; and thirdly there is also the possibility to generate colour or grey scale graduated tints as pixel graphics and incorporate these as fill patterns. This last possibility needs further explanation: In principle colour graduated tint pixel graphics naturally show up the same stepping problems, but here a much simpler remedy is possible by adding some random noise to the colour, which effectively suppresses the visibility of the borders: ONLY IN THIS WAY can one obtain first-class colour graduated tints suitable for printing!

For generating colour graduated tints with DA's VECTOR you basically have the following possibilities:

1. Generate a pixel graphic graduated tint with added noise and use this as a fill pattern.

2. Generate simple vector graduated tints with the 'Multi-Copy' function.

3. Generate any desired colour/shape fills with the Time-Space Converter.

4. Convert graduated tints generated with 2. or 3. to a pixel graphic, add noise and again use as a fill pattern - i.e. a combination of processes 1.

and 2. or 3.

You will find an exercise for all of these ways of generating a graduated tint which will explain the techniques in detail.

EXERCISE: Colour graduated tint with a 'noisy' pixel graphic
TASK: To create a simple colour graduated tint or halftone graduation as a pixel graphic with added random noise to suppress the formation of steps, and use this as a fill pattern of a vector area.

STEP 1: Go into the Vector Path Editor, fetch the square from the library onto the working area and return to the Vector Graphic Editor.

STEP 2: Select 'Transparent' for 'Line Attributes' and at first any desired fill colour for 'Area Attributes'.

STEP 3: Scale the square into a longish rectangle; as an exercise use proportions of 1:2 (width : height) here. Make a note of the height and width of the rectangle.

STEP 4: Under 'Services' select the 'Make halftone or colour graduated tint' accessory program. Now input the height and width of the rectangle you generated earlier. Under 'Resol.' you can choose between 'Fine' (high resolution for high quality print masters), 'Medium' (normal print masters) and 'Coarse' (for overhead transparencies, screen display for animation's etc.). Select a 'Start colour' and an 'End colour' in 'Colour-Grad' as well as a 'Startval.' and an 'Endval.' in 'Grey-Grad', since we wish to generate both types of graduated tints at the same time. In any case leave 'Noise' switched on (tick!) and select a simple vertical graduated tint (second icon in the top row). Now generate first a halftone graduated tint named 'GRAD_1.TIH' and then a colour graduated tint 'GRAD_2.TIC'. Then quit the GradTint Generator.

STEP 5: Go into the 'Area Attributes' sub-menu and load both graduated tints as fill patterns. Now select the rectangle and select first the colour graduated tint as the fill pattern with the 'Rel' setting on and 'Fix' switched off. You will now have the desired colour graduated tint area with a completely step-free graduation.

STEP 6: As an alternative now select the halftone graduated tint as the fill pattern. If you selected black as the colour you will get pure graduated greys; but you can also choose any desired colour in place of black and in this way obtain a colour graduated tint, which however has only one hue running from light to dark (or the other way round).

STEP 7: You can vary this exercise in many ways. The Graduated Tint Generator offers you 9 different graduated tints: Horizontal and vertical, two linear and two non-linear diagonal graduated tints, two types of circular graduated tint as well as a 'noisy' tone area that strictly speaking doesn't represent any kind of graduated tint but a random colour distribution between a start- and end-value (this permits the creation of more 'natural' looking colour areas than with pure tones). Interesting effects can also be achieved by using a small graduated tint as a repeating fill-pattern, achieved by setting the picture size smaller (switch on 'Fix' and input the picture size) than the surface size.

RESULT: With the help of the GradTint Generator you have produced high quality stepless colour and halftone graduated tints and inserted these as 'fill patterns' into simple vector areas. With variations of this exercise you can get to know the multiple possibilities offered by the various graduated tint types.

EXERCISE: Linear colour graduated tint by multi-copying
TASK: To generate a simple linear colour graduated tint by using the 'Multi-Copy' function.

STEP 1: Go into the Vector Path Editor and with four line paths construct a rectangle 100 mm wide and 1 mm high.

STEP 2: Go back into the Vector Graphic Editor; under 'Line Attributes' select 'Transparent' and under 'Area Attributes' select a pure blue (C=255, M=255, Y=0, K=0, or with 'RGB': R=0, G=0, B=255).

STEP 3: Select the object and call the 'Multi-Copy' function. Select by clicking on them the 'Distance' and 'Fill Colour' functions (the box must appear filled with black). Set the 'No of copies' to 199 and 'Distance' vertically (V) to 1 mm. Now choose as an end-colour a light cyan (C=64, M=0, Y=0, K=0). Click on 'OK' to generate the copies.

STEP 4: Now group the vertical colour graduated tint you have generated by first drawing a frame around the entire object while pressing the ALTER-

NATE-key in order to select all the objects, and then click on the 'Group objects' icon.

RESULT: You have created a simple vertical colour graduated tint with 200 steps by means of the 'Multi-Copy' function. This is the simplest way of generating standard graduated tints in DA's VECTOR. However, due to the many part-areas the object occupies a relatively large amount of storage space and due to the step-problem has only limited use for high quality print masters.

EXERCISE: Circular colour graduated tint by multi-copying
TASK: To generate a circular 'colour table' with 360 steps with the 'Multi-Copy' function.

STEP 1: Go into the Vector Path Editor and generate an isosceles triangle with side lengths of 80 mm at an angle of 1°. (Hint: First generate an 80 mm long line and make an identical copy via the clipboard; switch on the 'Rotate' tool and set the turning point centre exactly at the end of the copy of the line — very easily done with 'Snap to control point'; insert the short connecting line and combine the three partial paths with the 'crochet hook' into one.)

STEP 2: Go back to the Vector Graphic Editor and set 'Transparent' under 'Line Attributes'. In the 'Area Attributes' sub-menu select a pure cyan (C=255, others = 0) for the area colour.

STEP 3: Select the object and call the 'Multi-Copy' function. Select the 'Rotate' and 'Fill colour' options. Input a turning angle of 1° and set the number of copies to 60. Now you still have to select a pure green as the end colour (C=255, M=0, Y=255, K=0) and start the copy process by clicking on 'OK'. You now repeat the whole procedure five times, where you always select the last object of the previously produced copy series and set the next end colour in the following order: pure yellow; pure red; pure magenta; pure blue; as the last colour you set C=255, M=4, Y=0, K=0 and for the last copy process you set the number of copies to 59 instead of 60.

STEP 4: Now group the whole object by first of all drawing a frame around the whole object with depressed ALTERNATE-key so as to select all the objects within the frame, and then click on the 'Group' icon. You will also find a graphic object created in this way under the examples as 'COLORS3.HTV'. Load this object so that you can compare the object you have created with it.

RESULT: You have created a ‘colour circle’ with 360 colour steps by a 6-fold application of the ‘Multi-Copy’ function. This object should correspond to the example graphic ‘COLORS3.HTV’ and can be used as a colour table for ‘picking’ colours for use.

EXERCISE: Colour graduated tint with the Time-Space Converter
TASK: To create colour graduated tints with completely free shapes.

STEP 1: Go into the Vector Path Editor and create a nice organic closed shape with some Bézier curves.

STEP 2: Go into the Animation Editor. Under ‘Line Attributes’ select the ‘Transparent’ option and under ‘Area Attributes’ set y desired start colour for the graduated tint. Go into the ‘Film clipboard’ sub menu and take a snapshot of the object as ‘Picture 0’.

STEP 3: Now distort the object and at the same time make it smaller. For the distortion you can use all the scaling functions, the path tool, the calculator or the Bézier-surface transformation. You can position the new object so that it lies on top of the old object, or also wholly or partly next to it. This can be checked easily if BEFORE the manipulation (distortion) of the start object you switch on the ‘Origin picture in outline’ option. The ‘old’ unmodified object then remains visible in outline and you can position the new, modified object as you like in relation to it. Now you must select for the object the end colour of your desired colour graduated tint. Return to the Film clipboard, select, say, ‘Picture 63’ (to obtain 64 graduations) and take a snapshot of the object.

STEP 4: Go into the Animation Editor and throw away the remaining object into the Trashcan, or store it in the clipboard. Then click on the Time-Space Converter and DA’s VECTOR will generate for you an animation series ‘in position’, which means that all calculated intermediate pictures will be laid on top of each other and also immediately grouped into one object.

STEP 5: This exercise can be varied in many ways: Various start and end shapes, various positions of the two objects, various numbers of intermediate steps etc. Just make a few experiments; you will quickly get to know the virtually limitless possibilities offered by this function.

RESULT: With this exercise you have learned how you can generate with the aid of the Time-Space Converter colour graduated tints of practically any shape and position. These objects however need a great deal of storage space, and here too one will usually be able to see colour steps in a printout.

EXERCISE: Convert vector colour graduated tint to pixel graphic

TASK: In this exercise you will learn how to combine the advantages of various methods of generating colour graduated tints. The best quality is achieved with 'noisy' pixel graphics (colour or halftone) that are incorporated into vector graphics as fill patterns. The shape of the graduated tints created with the graduated tint generator is however limited to a few fundamental basic forms (vertical, horizontal, diagonal and circular). Vectorial colour graduated tints can be created with the aid of the 'Multi-Copy' function and the Time-Space Converter in virtually unlimited variations, but here one is always fighting the step-problem. In this exercise you will learn how one can create from a vectorial graduated tint a 'noisy' and with that step-free pixel graphic, which can then again be used as a fill pattern. This exercise presupposes that you have earlier already created a vectorial colour graduated tint, e.g. with the Time-Space Converter, as described in the corresponding exercise.

STEP 1: Load an object with the vectorial colour graduated tint created earlier, or create one now as described in the exercise 'Colour graduated tint with the Time-Space Converter'.

STEP 2: Under 'File' select the 'Print' menu entry. The 'Output Settings' dialogue box appears. Click on the field next to 'Driver' and then on 'TIFF ColorBlock (File *.TIC)' in the new dialogue. Select, depending on the desired quality, a resolution of 75, 150 or 300 dpi (best quality but largest memory requirement) and activate the selection 'Adjust: To Graphic'. If you now click on 'Print' you can create a colour picture file with a name of your choice.

STEP 3: Under 'File' select the 'Services' menu entry and there select the 'Add noise to colour pictures' accessory program. A file selector box appears and you select the previously created colour picture as a source picture and a new name for the destination picture. In the following dialogue you select the 'Medium' noise addition option.

STEP 4: You can now load this colour picture as a fill pattern and import it into any desired vector area as a fill pattern.

RESULT: In this exercise you have learned how you can combine the advantages of vectorial colour graduated tints (any desired shapes and steps) with those of a noisy pixel graduated tint (free of steps). You first created a vectorial graduated tint, 'printed' a colour picture from this, added noise and reloaded it as a (graduated tint) fill pattern.

Real Shadows

A shadow is perceived first as a darkening of the shadowed surface, and essentially defined by an unsharp border. This way the shadow is seen not as a coloured patch but as a shadowed area. We recognise the shadowed part of a white wall still as white with a shadow, not as a dark grey area. Only if one draws over the unsharp edge of a shadow with, say, a pencil and thus artificially hides the unsharpness will the shadow be forcibly (!) perceived as a colour patch.

Every shadow consists of a so-called 'core shadow' and an unsharp edge region (penumbra) that fades away into the colour of the background. If the background is a white toned area then the core shadow should be mid- to dark-grey and the unsharp edge should be realised as a transition (graduated tint) from the core shadow colour to white. The 'Real shadows 1' exercise shows the principle very nicely with the example of a simple circular shape. If the shadowed background is a coloured area then the colour of the core shadow should be a darkening of this background colour, which one achieves easily by adding more or less of the K-portion to the background colour. With darker backgrounds it is better to use a lightened background colour (same PROPORTIONS of the constituent colours) and darken this with an added K-portion, to prevent unpleasant colour shifts. In the 'Real shadows 2' exercise this is demonstrated with a simple circular shape.

If the shadowed background shows a surface structure then the shadow should also show the same structure. In DA's VECTOR structured backgrounds are realised with fill pattern graphics. In the 'Real shadows 3' exercise one again uses a simple circular example to demonstrate how such 'structured shadows' are realised.

With more complex shapes the construction of the core shadow can become difficult, since a 'narrowing' of the picture is involved that can really only be achieved by modifying the paths. The same applies naturally to the 'widened' shadow edge. In many cases one can overcome this problem with a trick, where there is no narrowing of the core shadow but an almost equivalent effect is achieved through a 'widening' of the penumbra. The 'Real shadows 4' exercise demonstrates this process.

With these four exercises you will learn the basic processes, though these can also be modified in many ways. Thus for instance shadows can be produced with perspective distortion, as they would be portrayed on a 'slanting' wall. Even shadows on a curved surface are possible using the Bézier-surface transformation.

Since shadows are constructed with vectorial graduated tints they naturally also suffer from the unavoidable 'steppiness' of such fills, though these are less conspicuous due to the relatively small areas they occupy. If one wants to completely avoid these steps, one can generate from the shadow object a fill pattern graphic, add noise to it and then use this to fill a shadow outline. You will find more about this technique in the exercises for colour graduated tints.

EXERCISE: Real shadows 1 - On a white background
TASK: A circle is to be given a shadow, making the object appear to 'float' in space. The most important part of the task however is the realisation of as genuine an impression of a shadow as possible with the facilities offered by DA's VECTOR — in this simple case on a white, single-toned background.

> **STEP 1**: As a simple example we will first choose a circle, as with it one can very easily see the relationship between the 'core shadow' and the shadow edge (penumbra). For this go into the Vector Path Editor and fetch the circle from the library.
>
> **STEP 2**: Go back to the Vector Graphic Editor and set the object attributes as follows: Line to 'Transparent', object colour black. Now store a copy of the object in the clipboard.
>
> **STEP 3**: Now go into the Animation Editor, since we want to use the Time-Space Converter for generating the shadow. As an aid switch on the option 'Origin picture in outline'. For the object colour select C=0, M=0, Y=0, K=8. Now enlarge the circle proportionally by some 15% and position it so that it has the same centre as the original circle. Go into the Film clipboard and take a snapshot as 'Picture 0'.
>
> **STEP 4**: Throw the circle into the Trashcan. Fetch a copy of the original circle (with depressed CONTROL-key!) from the clipboard and switch the

'Original picture in outline' option off and then on again. Select C=0, M=0, Y=0, K=160 for the object colour. Now reduce the circle by some 15% and position it so that its centre coincides with that of the original picture. In the Film clipboard store a snapshot as 'Picture 31'.

STEP 5: Go into the Vector Graphic Editor and throw the current object into the Trashcan. Click on the Time-Space Converter icon. The total 'animation' will be stored with all pictures on top of one another and in this way you achieve your first shadow object. The dark core shadow is smaller than the object throwing it, the total shadow object is larger and graduates from the core shadow into the white background (the working area). In order to check the impressions of the shadow you should switch off the guideline raster, or place a white area in the background.

STEP 6: Fetch a copy of the original object (black circle) from the clipboard and position it with a certain offset to the shadow in order to achieve the effect of the object floating above the shadowed surface.

RESULT: In this first exercise of the 'Shadows' theme you have constructed a shadow on a white background to a simple circular shape. This shadow object consists of a 'reduced' core shadow and an unsharp, broadened penumbra that graduates into the white of the background surface.

EXERCISE: Real shadows 2 - On a coloured background

TASK: A circle is to be given a shadow, making the object appear to 'float' in space. The most important part of the task however is the realisation of as genuine an impression of a shadow as possible with the facilities offered by DA's VECTOR — in this simple case on a coloured, single-toned background.

STEP 1: First we need a coloured area as a background. For this go into the Vector Path Editor and fetch the square from the library.

STEP 2: Now go into the Vector Graphic Editor and enlarge the square to fill the whole working area. Set the following attributes for the coloured area: Line 'Transparent', surface colour light pink (C=0, M=64, Y=32, K=0). Now store this background area in the clipboard (move, not copy!), since we will need it later.

STEP 3: As a simple example we will first choose a circle, as with it one can very easily see the relationship between the 'core shadow' and the shadow edge (penumbra). For this go into the Vector Path Editor and fetch the circle from the library.

STEP 4: Go back to the Vector Graphic Editor and set the object attributes as follows: Line to 'Transparent', Object colour black. Now store a copy of the object in the clipboard.

STEP 5: Now go into the Animation Editor, since we want to use the Time-Space Converter for generating the shadow. As an aid switch on the option 'Origin picture in outline'. For the object colour select C=0, M=64, Y=32, K=8. Now enlarge the circle proportionally by some 15% and position it so that it has the same centre as the original circle. Go into the Film clipboard and take a snapshot as 'Picture 0'.

STEP 6: Throw the circle into the Trashcan. Fetch a copy of the original circle (with depressed CONTROL-key!) from the clipboard and switch the 'Original picture in outline' option off and then on again. Select C=0, M=64, Y=32, K=160 for the object colour. Now reduce the circle by some 15% and position it so that its centre coincides with that of the original picture. In the Film clipboard store a snapshot as 'Picture 31'.

STEP 7: Go into the Vector Graphic Editor and throw the current object into the Trashcan. Fetch the coloured square created earlier from the clipboard. Now click on the Time-Space Converter icon. The total 'animation' will be stored with all pictures on top of one another and in this way you achieve your shadow object. The dark core shadow is smaller than the object throwing it, the total shadow object is larger and graduates from the dark pink core shadow into the light pink background.

STEP 8: Fetch a copy of the original object (black circle) from the clipboard and position it with a certain offset to the shadow in order to achieve the effect of the object floating above the shadowed surface.

RESULT: In this second exercise of the 'Shadows' theme you have constructed a shadow on a coloured background to a simple circular shape. This shadow object consists of a 'reduced' core shadow and an unsharp, broadened penumbra that graduates into the colour of the background surface.

EXERCISE: Real shadows 3 - On a structured background
TASK: A circle is to be given a shadow, making the object appear to 'float' in space. The most important part of the task however is the realisation of as genu-

ine an impression of a shadow as possible with the facilities offered by DA's VECTOR — in this simple case on a structured, coloured background. The structure of the background is realised via a fill pattern (halftone with colour added).

STEP 1: Since one can lighten but not darken (halftone) fill patterns, we have to first of all generate a sufficiently dark fill pattern. To do this call under 'Services' the graduated tint generator ('Create colour or halftone graduation') and choose in this 'Noisy tone area' (upper left icon). Set the output size to 102.4 * 102.4 mm and the resolution to 'Coarse'. Under 'Grey run' enter 80% as the 'Startval.' and 100% as 'Endval.'. Now click on 'Create Grey run', entering a name of your choice in the file selector but using a '.TIH' extension, and then return to DA's VECTOR.

STEP 2: First we need a coloured area as a background. For this go into the Vector Path Editor and fetch the square from the library.

STEP 3: Now go into the Vector Graphic Editor and enlarge the square to fill the whole working area. Set the following attributes for the coloured area: Line 'Transparent', surface colour a darkened pink (C=0, M=64, Y=32, K=64). Now load the previously generated fill pattern and activate it for the object. Set the following attributes for the fill pattern: 'Abs', 'Fix' ON, position 0,0 and Size = 819.2 * 819.2. Store this background surface in the clipboard (move, not copy!), since we will need it later.

STEP 4: As a simple example we will first choose a circle, as with it one can very easily see the relationship between the 'core shadow' and the shadow edge (penumbra). For this go into the Vector Path Editor and fetch the circle from the library.

STEP 5: Go back to the Vector Graphic Editor and set the object attributes as follows: Line to 'Transparent', Object colour black. Now store a copy of the object in the clipboard.

STEP 6: Now go into the Animation Editor, since we want to use the Time-Space Converter for generating the shadow. As an aid switch on the option 'Origin picture in outline'. For the object colour select C=0, M=64, Y=32, K=64 and give the fill pattern the same attributes as the background surface ('Abs', 'Fix' ON, position 0,0 and size 819.2 * 819.2). Now enlarge the circle proportionally by some 15% and position it so that it has the same centre as the original circle. Go into the Film clipboard and take a snapshot as 'Picture 0'.

STEP 7: Throw the circle into the Trashcan. Fetch a copy of the original circle (with depressed CONTROL-key!) from the clipboard and switch the 'Original picture in outline' option off and then on again. Select C=0, M=64, Y=32, K=160 for the object colour and for the fill pattern the same attributes as the background surface ('Abs', 'Fix' ON, position 0,0 and size 819.2 * 819.2). Now reduce the circle by some 15% and position it so that its centre coincides with that of the original picture. In the Film clipboard store a snapshot as 'Picture 31'.

STEP 8: Go into the Vector Graphic Editor and throw the current object into the Trashcan. Fetch the coloured square created earlier from the clipboard. Now click on the Time-Space Converter icon. The total 'animation' will be stored with all pictures on top of one another and in this way you achieve your shadow object. The dark core shadow is smaller than the object throwing it, the total shadow object is larger and graduates from the dark pink core shadow into the mid-pink background, where the shadow shows the same structure as the background surface; to show this was the whole purpose of this exercise.

STEP 9: Fetch a copy of the original object (black circle) from the clipboard and position it with a certain offset to the shadow in order to achieve the effect of the object floating above the shadowed surface.

RESULT: In this third exercise of the 'Shadows' theme you have constructed a shadow on a coloured and structured background to a simple circular shape. This shadow object consists of a 'reduced' core shadow and an unsharp, broadened penumbra that graduates into the colour and structure of the background surface. Building up the picture for such an object can take some considerable time — after all 33 fill patterns have to be drawn on top of one another. You can easily remedy this by 'printing' the background together with the shadow image (but without the object throwing the shadow) as a (TIC!) picture and then incorporating it as a fill pattern for the background square. Now the shadow is a part of the picture. The unsharpness that may result makes no difference here, since the shadow should be unsharp in any case.

EXERCISE: Real shadows 4 - More complex forms

TASK: The separation of the core shadow and the penumbra can be realised easily only with simple shapes. With complex shapes, such as text, this is only possible with a lot of manual work by editing the individual paths. Here a different procedure is to be preferred which while not 'narrowing' the core shadow at least creates the outer penumbra in an optimal way. In this exercise we will generate such a complex shadow.

STEP 1: Go into the 'Vector Text' sub menu and call the text object settings dialogue. Select a font of your choice, preferably a bold face. Set a text size of around 30-50 mm. Quit the text dialogue and input a short (line) text from the keyboard, say your first name. Now quit the 'Vector Text' sub menu and dissolve the object by clicking on the 'Ungroup group' icon. You will now first have as many (selected) individual objects as the number of letters you entered. Form a single path object by clicking on the 'Group objects' icon. Set the attributes of this new object as follows: Line colour black, line ends square (centre icon), line thickness 0.00 mm (hairline), surface colour black (C=0, M=0, Y=0, K=255). Now store a copy of the object in the clipboard, since we will need it again later.

STEP 2: Go into the Animation Editor. Set the area and line colour both to the value: C=0, M=0, Y=0, K=160. Go into the 'Film clipboard' sub menu and take a snapshot as 'Picture 15'.

STEP 3: Now for the same object set the line colour to K=10 and the line thickness to 10 - 20% of the character size (thus for instance to 7.5 mm for 50 mm character size). In the Film clipboard take a snapshot as 'Picture 0'.

STEP 4: Go into the Vector Graphic Editor and throw the object into the Trashcan. Start the Time-Space Converter, which will produce for you the desired shadow object. Place this shadow object on a white background, or just switch off the guide raster to achieve this.

STEP 5: Fetch the original object (black text) from the clipboard and position it with a certain offset over the shadow.

RESULT: In this exercise you have constructed a realistic-looking shadow for a really complex object (text). In contrast to the other exercises with shadows the Time-Space Converter was used here to generate the unsharp shadows from the object outlines. The core shadow cannot be made smaller with this method, but the unsharp penumbra can be generated very simply in this way even for very complex shapes. Naturally one could extend this exercise which used a grey graduated tint very easily to shadowed colour areas (which need coloured shadows). Shadowing of structured areas is however not possible with this procedure.

Fill Patterns

One of the great strengths of DA's VECTOR is the ability to use any size of halftone, palette or TrueColour pictures for filling vector areas. This 'fill pattern function' can be used in many ways:

For a start one can very simply integrate colour or halftone pictures (photographs) into the graphic. One only needs a simple frame (rectangle of suitable proportions) and inserts the desired picture as a 'fill pattern' — and there's the 'picture object'. In the 'Vectorising' menu there is a special function to do this which automatically generates a 'picture object' (not possible with palette pictures!).

Such picture objects are however not restricted to rectangular shapes. Any path, however complex, can be filled with pictures as fill patterns, or, seen another way, DA's VECTOR is an excellent (lithographic) tool for vectorially cutting out pictures so that they are freestanding.

A further application consists of adding natural structures to vector areas. In nature there are no single-coloured (single-toned) surfaces. Each surface has a quite characteristic structure. Vector graphic objects with pure tone areas (and perhaps colour graduated tints) thus always somehow appear as 'artificial'. You can scan in such natural surfaces (directly from an object or from photographs) and then use them as a fill for vector areas. For this you should either treat them as photographs, which therefore do not repeat themselves as a fill pattern (in which case they have to be sufficiently large!), or generate symmetrical fill patterns that may be repeated without disturbing edge effects when joined up.

Besides natural structures one can of course realise any kind of 'artificial' or 'technical' structures with fill patterns. No limits are set to one's imagination for this. Such fill patterns can be produced with (colour) paint programs or in picture processing (editing) programs and converted to the TIH- or TIC-format by the 'PicConverter'. Palette pictures in the TIP-format cannot be handled by the converter at present. Right now these can only be produced with DA's REPRO CD — in the near future naturally also with DA's PICTURE. But even if you don't possess a paint or picture processing program you can create your own fill patterns. Since DA's VECTOR can also 'print' to picture files in TIH and TIC formats, the fill patterns can be created first as vector graphics and then output as halftone or colour pictures (see 'Generating one's own fill patterns').

The picture size (picture resolution) of fill patterns should be adapted towards the area of application: For high quality print masters the resolution should lie between 150 and 300 dpi. For use on display screens and with computer printers resolutions of 75 - 150 dpi suffice. The bundled fill patterns should serve as suggestions. Naturally we couldn't include any high resolution scanned surfaces since these would hardly fit on floppy discs.

Generating One's Own Fill Patterns

If you don't want to use scanned structures as fill patterns, then you can create fill patterns with virtually any paint or picture retouching/processing program, or also with DA's VECTOR by outputting ('printing') a vector graphic to a picture file (TIH or TIC). Naturally you can also combine both processes. In this chapter we want to give you some tips for the creation of fill patterns, where we will first deal with the principles of constructing pixel graphics and making them symmetrical, and then the creation of fill patterns with DA's VECTOR. There are also suitable exercise on this theme.

If one wants to use repeating scanned structures (the classical fill pattern principle), then these have to be treated afterwards in a picture processing program such as DA's REPRO CD or DA's PICTURE: Select a suitable cut out portion (block) and then quadruple it, where the constituent parts are mirrored horizontally and/or vertically to form a symmetrical fill pattern in the following manner:

normal	vertical
horizont.	hor.+vert.

Note that 'horizontal' or 'vertical' mirroring means reflection round the 'horizontal' or 'vertical' AXIS. Simple patterns (e.g. closed pictures on a toned area) and suitable geometric structures need not be mirrored, since they will fit flush next to each other as they are.

In order to generate fill patterns with DA's VECTOR itself without the aid of paint or picture processing programs, you basically proceed as follows: You first create the fill pattern as a vector graphic, group all the parts and select the group. Then you click on 'Print' in the 'File' menu and select as the output driver the TIH- (halftone) or the TIC-format. (DA's VECTOR offers the extraordinarily useful facility of being able to 'print' to a picture file.) In the 'Output Settings' dialogue you activate 'Adjust: To graphic'. Now you only need to input the resolution in dpi (see below) and you are ready to output the file.

The resolution at which you output the picture should be suitable for the ultimate purpose it is to be put to, since while the fill pattern may be freely scalable, it must possess a minimum resolution in order not to appear 'blocky'. The picture size depends on the one hand on the size of the graphic object, and on the other on the output resolution according to the following formula:

*Output width (in Pixels) = Width (mm) * 10 * Resolution (dpi) / 254*

The picture height may be calculated in a similar manner.

Particularly simple relationships will be achieved with the resolution of 127 dpi:

*Picture width (in Pixels) = Object width (mm) * 5*

The picture sharpness (edge sharpness, line sharpness) of a fill pattern when printed later follows from the relationship of the fill pattern size (in mm) to the picture size (in pixels) according to the following formula:

*Sharpness (in dpi) = Fill pattern width (mm) * 10 / picture width (pixel) *254*

So for example: A fill pattern of 100 pixels picture width is set in DA's VECTOR to a width of 10 mm. This will give a 'line sharpness' of 254 dpi. For photographs and scanned structures this is already a pretty good value that will usually suffice for good print quality. The line sharpness that one should roughly work with is given in the following overview:

Screen, computer printer 300 - 600 dpi; newsprint 75 - 150 dpi

High quality offset printing with scanned material (photographs, structures): 150 - 300 dpi

Fill patterns with geometric elements and text for high quality offset printing: 300 - 600 dpi.

EXERCISE: Tiles as fill patterns

TASK: To create a simple but typical kitchen tile as a fill pattern and tile a wall with them. For this colour graduated tints, the Time-Space Converter and adding noise to pictures are all used to produce as naturally looking a tile with 3D effect as possible.

STEP 1: Go into the Vector Path Editor and fetch the square from the library.

STEP 2: Go into the Vector Graphic Editor and set the attributes of this square as follows: Lines 'Transparent'; fill colour C=5, M=10, Y=25, K=5. Set the guideline spacing in 'Page format' to 5 mm and let the square snap to the guide grid (makes further work easier). Store a copy in the clipboard.

STEP 3: Go now to the Animation Editor and take a snapshot as 'Picture 15'. Now enlarge the square on all four sides by 5mm (very easy with snap to guides!). Set the following attributes: Line colour and area colour to C=5, M=10, Y=25, Y=75; line 'Coloured' (not 'Transparent' as earlier); line ends round (right icon); line width 1.00 mm. Take a snapshot as 'Picture 0'.

STEP 4: Go back to the Vector Graphic Editor. You will find on the working area the enlarged and darkened area, which you have just saved as 'Picture 0'. The properties of this square will now be altered again: Line ends square (centre icon); line colour C=M=Y=0, K=160; Line width 10.00 mm.

STEP 5: Now click on the Time-Space Converter. It generates the 'Animation in position' and actually exactly over the rectangle with the grey outline lying there. Group this new object with the square lying under it to form a single object.

STEP 6: With the object selected click under 'File' on the 'Print' menu entry. The 'Output Settings' dialogue appears. Load the driver 'TIFF ColorBlock (File *.TIC)'. Select a resolution of 127 dpi and activate the setting: 'Adjust: To Graphic'. If you now click on 'Print', the file selector will appear. Input 'TILE.TIC' as the name. Now a colour picture file under this name will be created.

STEP 7: In the 'File' menu select the 'Services' menu entry and in that select the 'Add noise to colour pictures' accessory program. A file selector appears in which you now choose the previously created colour picture 'TILE.TIC' as a source picture, and a new 'TILE_R.TIC' as the destination picture. In the following dialogue choose the 'Medium' noise option.

STEP 8: In DA'S VECTOR you now fetch the original square from the clipboard. Go into the 'Area attributes' sub menu and load 'TILE_R.TIC' as a fill pattern. Select the fill pattern and switch pattern fill on for the square area. Set the fill pattern options to 'Rel' and 'Fix' (switched on) and the fill pattern size to 10.00 * 10.00 mm. Now you have a square tiled wall on the screen with yellowish-white tiles on a dark grey ground.

RESULT: You have created in DA's VECTOR a yellowish-white tile with a 3D look on a dark (jointed) ground. This was output as a colour picture and overlaid with random noise to achieve the impression of a natural surface. Then you have inserted this picture as a repetitive fill pattern (of very high quality) in a 'tiled wall'. This exercise can be varied in many ways — and each time results in an interesting fill pattern: Different tile and join colours, painted tiles, tiles with surface structures (fill patterns inside the tiles) etc. And what do you do with them? Why don't you put your fill patterns into the 'swop exchange' (our E-mail mailbox)! If many users do this then a huge number of fill patterns will materialise.

EXERCISE: Hatching as fill patterns

TASK: In technically oriented applications above all one often needs hatching and similar operations. A number of users have asked us whether we couldn't build in such things. But that is not necessary at all, since such problems can be solved easily by appropriate fill patterns. The aim of the following exercise is the creation of such a hatching pattern with DA's VECTOR.

STEP 1: In a new document set a page format of 100 * 100 mm at the position 100,100. Then go into the Vector Path Editor and create a narrow diagonal rectangle that just protrudes over the corners of the page, so that it goes into the apex. This is particularly easy with a suitable guideline raster and raster snap switched on.

STEP 2: Go back to the Vector Graphic Editor and set black as the fill colour and 'Transparent' for the line colour. Store a copy of the object in the clipboard and fetch two such copies onto the working area. Position both these diagonal bars over the lower left and upper right corner, so that the apex protrudes into it by half the bar width (as exactly as possible, best again with snap to guideline raster).

STEP 3: Now call the 'Output Settings' dialogue, click on the field next to 'Driver', then on 'TIFF GrayBlock (File *.TIH'). Output the page with, for instance, a resolution of 127 - 300 dpi as a halftone picture under a name of your choice.

STEP 4: Load this halftone picture as a fill pattern. Draw up a large area (or fetch the square from the library) and fill this area with this fill pattern with the setting 'Fix' (selected) and a size of around 5 * 5 mm. On the screen the hatching can appear to 'run together' when reduced by a large amount. Don't let yourself be irritated by this; take a look at the hatching as a check under strong magnification.

RESULT: You have created the first fill pattern for hatching. You can also vary this in many ways: Different bar widths, separations, directions etc. The fill pattern itself can be coloured in any way desired during use, so that with this you already possess hatching in any desired colour.

DA'S VECTOR As A Litho Tool

Though it was not intended for it, resourceful users have discovered a new application for DA's VECTOR: They apply it as a lithographic tool. This means that they load a (scanned) colour or halftone picture, mostly present in a high resolution, as a 'picture object', then 'edit' or modify it with tools in DA's VECTOR and then output it as an equally high resolution colour or halftone picture (during this it is even possible to produce automatic colour separations and printing-colour corrections). Such modification possibilities include: Inserting text, logos and graphics of any kind into photographs; (vectorial) freestanding cut outs; picture montages (paste-ups) etc. At first sight this appears trivial perhaps (and maybe it is), but a lot of money is involved here: Those who know how much such lithographic work costs in a service bureau will surely know how to appreciate these capabilities of DA's VECTOR.

So as not to endanger the picture quality, the output picture should either have the same resolution as the source picture or an integer multiple of it; if, for instance, the originals of only relatively small size, then the inserted vector text may become 'blocky'; in that cases output at double or treble size is very sensible, since then the text will possess a much higher edge sharpness. But how does one calculate the output size?

For an output at 127 dpi (which is present in all drivers that output to a file) the size of the picture in DA's VECTOR (shown in the coordinate display) INCLUSIVE of the FIRST decimal place corresponds to the picture size in pixels times 2. As an example: the picture object in DA's VECTOR has a size of 200.0 * 111.2 mm; then the output (with 127 dpi and 100% output size) would result in a picture of 1000 * 556 picture points. But you can simplify matters even further if you go to 200% for the output; then the resultant picture size corresponds exactly to the internal coordinate system with the exception of the second place after the decimal point.

For output one should naturally always take into consideration at what resultant size the picture will be finally printed (or output). If the picture is to be greatly reduced (compared to the scanned 'original') then an inflation of the size is hardly necessary;' if on the other hand it will be 'blown up' during output then one should go to a double or triple picture size in order to safeguard the 'line sharpness' (edge sharpness) of the inserted graphic or of the freestanding cutout.

A special option is offered by output in the 'TIFF 5.0' format. If you select '4 Colours' for 'Medium:' the picture will be colour separated during output, and colour corrected for reproduction with offset printing colours corresponding to the DIN 16509 standard. One can therefore even use DA's VECTOR for colour correction of colour photographs for printing (within certain limits due to not being able to set any parameters).

EXERCISE: Lithographic application 1: Inserting text
TASK: To insert text into a colour photograph available as a high resolution 'scan' (fine data), then saving the result again as a high resolution colour picture (> 300dpi). For this task you must know the size of the picture in pixels (width times height). This information you will normally get from your picture processing or scan software.

STEP 1: Go into the tracer ('Vectorisation' in the 'Edit' menu) and import a colour picture, which must be in the '.TIC' format. Click on the 'Create Picture Objects' icon and go into the Vector Graphic Editor; there you will now find a picture object, which means a rectangular frame with the picture as a fill pattern. Go into the 'Area Attributes' sub menu and switch the 'Fix' field off the 'Rel' on.

STEP 2: Create a vector text in the desired size and colour and position this on the picture. Group the picture and the vector text into one object.

STEP 3: Now the result must be output again as a colour picture; this is very simple in principle, but one must first bring the picture (with the vector text) to a suitable size. Therefore scale the picture object proportionately in such a way that the height and width correspond to the picture size in pixels of the original picture up to the first decimal place, or to an integer multiple thereof (*2, *3 or *4 — depending on the desired quality and the expected file size). Select the 'Print' menu entry and in the 'Output Settings' dialogue a suitable driver (depending on the desired graphic format 'TIFF 5.0', 'TIFF ColorBlock (File *.TIC)' or — for halftone pictures — 'TIFF Grey Block (File *.TIH')). With the TIFF 5.0 output you can make a choice between 'Halftone', '3 Colour' and '4 Colour' output. In the last case the picture will also be immediately colour separated, and colour corrected for reproduction with printing colours corresponding to the DIN 16509 standard. Choose 127 dpi for 'Resolution:', an enlargement factor of 200% in 'Size:' and, NOT TO BE FORGOTTEN, under 'Adjust:' click on 'To Graphic' so that ONLY THE PICTURE OBJECT will be output.

RESULT: You have inserted a vector text into a high resolution colour picture and output the result again as a colour picture with the same or higher resolution.

With that you have completed the first simple lithographic basic exercise with DA's VECTOR. During output the picture could optionally also be separated and colour corrected immediately.

EXERCISE: Lithographic application 2: Cut out freestanding area
TASK: To cut out any desired area in a colour photo with a vector path to be freestanding, and output the result again as a high resolution colour picture. For this task you must know the size of the picture in pixels (width times height). This information you will normally get from your picture processing or scan software.

STEP 1: Go into the tracer ('Vectorisation' in the 'Edit' menu) and import the colour picture, which must be in the '.TIC' format. Click on the 'Create Picture Objects' icon and go into the Vector Graphic Editor; there you will now find a picture object, which means a rectangular frame with the picture as a fill pattern. Go into the 'Area Attributes' sub menu and switch the 'Fix' field off and 'Rel' on.

STEP 2: Select the picture object, go into the Vector Path Editor and switch on the display of the background picture. Construct/draw a vector path that surrounds the required portion of the colour picture as exactly as possible. DA's VECTOR supports this with a high resolution display of the background picture and the continuously variable zoom function. When done you cut through the middle of the four picture-surround lines and drag the resultant end points (2 in each case) to left and right / up and down EXACTLY onto the corner points (no problem with 'Snap to control points'). Finally you return to the Vector Graphic Editor. There the picture will appear as freestanding, cut out by the vector path you constructed.

STEP 3: Now the result must be output again as a colour picture; this is very simple in principle, but one must first bring the picture (with the vector path) to a suitable size. Therefore scale the picture object proportionately in such a way that the height and width correspond to the picture size in pixels of the original picture up to the first decimal place, or to an integer multiple thereof (*2, *3 or *4 — depending on the desired quality and the expected file size). If you go to a multiple of the size, the individual picture points (pixels) will even be cut by the vector path. Select the 'Print' menu entry and in the 'Output settings' dialogue a suitable driver (depending on the desired graphic format 'TIFF 5.0', 'TIFF ColorBlock (File *.TIC)' or — for halftone pictures — 'TIFF Grey Block (File *.TIH')). With the TIFF 5.0 output you can make a choice between 'Halftone', '3 Colour' and '4 Colour' output. In the last case the picture will also be immediately colour separated, and colour corrected for reproduction with printing colours corresponding to the DIN 16509 standard. Choose 127 dpi for 'Resolution:', an enlargement factor of 200% in 'Size:' and, NOT TO BE FORGOTTEN, under 'Adjust:' click on 'To Graphic' so that ONLY THE PICTURE OBJECT will be output.

RESULT: You have cut out a freestanding part from a high resolution colour picture and output the result again as a colour picture with the same or higher resolution. With that you have performed a simple lithographic basic exercise with DA's VECTOR. During output the picture could optionally also be separated and colour corrected immediately.

Vector Text

Vector text represents an object type of its own. This has a number of advantages and some restrictions compared to 'normal' vector graphic objects. First of all the memory space required for vector text is reduced appreciably, since each character only exists once in memory as a vector graphic (in the font) and thus does not need to be created repeatedly when the character is repeated several times. Lengthy text passages would otherwise fill up the memory very quickly. A further advantage lies in the fact that vector text is editable, which means that it can be edited later in the text mode. The third and perhaps most important advantage is the support for 'hinting' with PostScript Type 1 fonts; this greatly enhances the quality of reproduction at low and medium resolutions (screen, laser printer etc.).

All these advantages are countered by certain disadvantages: Vector text can only be transformed in limited ways (only proportionally); if you want to distort it in other ways the vector text must first be converted to a normal vector object. The program undertakes such a conversion automatically (after a warning). Such a converted text is however no longer editable as text and hinting is also no longer supported. But in return it may be subjected to any desired transformation, and outline characters also become possible. You must decide in each individual case which qualities are more important to you.

Naturally DA's VECTOR is not intended for large-scale text setting, but the capabilities are quite sufficient for pure job-work and design purposes. Even simple justified multi-line text and manual hyphenation can be carried out.

EXERCISE: Simultaneous internal and external circular text
TASK: To create a dual concentric circular text, where the inner text is to have the same orientation and text direction as the outer.

STEP 1: Go into the 'Vector Text' sub menu of the Vector Graphic Editor, and lay down first the circumference of the outer circle (that will be surrounded outside by the text). Click on the 'Set text object' icon and in the following dialogue select a suitable character size. Since the size of the circle (in this example) is not to be altered by the amount of text, switch on 'Adjust: Point
Size'; otherwise the size of the circle can change very quickly if you input too much text. Select 'Circular Text' with the radius 'x' (e.g. 50 mm) and input your text from the keyboard.

STEP 2: Go once more into the 'Vector Text' dialogue and set a second radius that is smaller by exactly the Cap height (or even a little more!). Position this circular text line on the working area as centrally as possible inside the other circular text, and input the second (inner) text.

STEP 3: Go back into the Vector Graphic Editor, check whether the inner circle is exactly concentric with the outer and if necessary correct its position by moving the inner circle. Next group both of the text objects together into one group object so that the two parts can no longer move relative to one another.

RESULT: Circular text normally 'stands' with its base line on the circle, which is why text inside a circle has a reversed orientation. For a dual circular text (inner as outer) one needs the same text orientation as a rule. In this exercise you have learned how such a dual circular text may be created in a simple way from two (outer) circular texts.

EXERCISE: Spiral setting
TASK: To set a text along a spiral.

STEP 1: Go into the Vector Path Editor and create an inwards spiralling curve with some Bézier curves.

STEP 2: Go back into the Vector Graphic Editor. In the 'Area Attributes' sub menu set the fill as 'Transparent' and in the 'Line Attributes' sub menu set any desired line width and colour (after all you must be able to see the path). Now go into the 'Vector Text' sub menu. Open the 'Text Object' settings dialogue, select 'Path Text' and the desired character attributes (font, size etc.). Quit the dialogue with 'OK'.

STEP 3: Select the icon for text along vector path (far left) and click on the path. You will automatically reach the text input mode and can type in the desired text. Following this return to the Vector Path Editor. You can now throw the path into the Trashcan since it is no longer needed. Naturally you can also combine it with the text into a group if you wish to keep it.

RESULT: You have created a spiral text along a vector path. Of course you can create any desired type of path text in a similar manner. This exercise is intended to demonstrate the manipulation of text along vector paths.

EXERCISE: Textured characters

TASK: To underlay text with a fill pattern picture (e.g. wood grain).

STEP 1: Go into the 'Vector Text' sub menu of the Vector Graphic Editor and create a simple line text (as an example — this exercise can naturally be carried out equally well with any other text shape).

STEP 2: Go back into the Vector Graphic Editor and save a copy of the text object in the clipboard. Now select the vector text object on the working area and click on the 'Dissolve Group' icon. Answer the query with 'YES'. Now you will see all characters as individual vector objects that are all selected. Click on the 'Join Paths' icon to unite all the characters into one path object.

STEP 3: In the 'Area Attributes' sub menu load a suitable fill pattern (for instance WOOD02.TIH) and activate it. Switch on the 'Rel' and 'Fix' options. If the fill pattern was a halftone picture (as in the above example) choose a suitable colour tint, for instance a dark (!) brown. You can still change the repetition size of the fill pattern from the keyboard, and with it the size or the resolution of the microstructure.

RESULT: You have created a text with a natural structure (e.g. wood grain). For this the text had to be dissolved and turned into a path object. This exercise is naturally only meant to explain the principle and may be varied endlessly.

EXERCISE: Outline text with colour graduated tints in the contours
TASK: To create a text with a fill colour and an additional outline, that in turn shows a colour graduated tint.

STEP 1: Go into the 'Vector Text' sub menu of the Vector Graphic Editor and create a simple line text (as an example — this exercise can naturally be carried out equally well with any other text shape).

STEP 2: Go back into the Vector Graphic Editor and save a copy of the text object in the clipboard. Now select the vector text object on the working area and click on the 'Dissolve Group' icon. Answer the query with 'YES'. Now you will see all characters as individual vector objects that are all selected. Click on the 'Join Paths' icon to unite all the characters into one path object. Select 'Transparent' under 'Area Attributes' and store a copy of the path object in the clipboard.

STEP 3: Now go into the 'Line Attributes' sub menu and select a line width and a line colour. We are suggesting simple values here that you can vary according to your taste: Line width 0.5 mm (for 10mm Cap height); for the line colour you should choose a brilliant colour which you then darken with a hefty K-portion.

STEP 4: Now go into the Animation Editor and take a snapshot as 'Picture 0'. Alter the line width to 0.05 mm and remove the K-portion from the line colour. Take a snapshot as 'Picture 9' and after that throw the text into the trashcan.

STEP 5: Go back to the Vector Graphic Editor and start the Time-Space Converter. After a short time the text will appear on the working area with a 'neon effect' in the outline.

RESULT: In this exercise you have learned how to generate an outline text and provide this with a glowing 'neon effect' colour graduated tint. The Time-Space Converter was used for this, with which one can produce the most crafty effects if one only knows how to do it.

EXERCISE: 3D-transformations without depth
TASK: To create any desired perspective representation of an object.

STEP 1: Get any desired single-coloured graphic object, for instance the DA logo, from the library.

STEP 2: Select the object and go into the '3D Extruder' sub menu. Set the 'Extrude Depth' (T) to 0! Now position the object with the three sliders any way you like in space. Then quit the sub menu.

RESULT: It has been shown that with the 3D Extruder one can also transform the perspective representation of an object without having to create depth with light and shade. In contrast to the normal (restricted) perspective transformation in the Vector Graphic Editor one has a completely free choice of perspective here. The object does not alter its structure during this (since no depth dimension is being created); for this reason one can also use this transformation for the Animation Editor, whereas 3D objects produced in other ways (with depth) usually do not maintain the same structure and therefore cannot be converted into one another in an animation.

KNOWHOW: Charts

The Chart Editor of DA's VECTOR is meant to fulfil two functions: On the one hand frequently used chart forms should be created almost at the press of a button, and on the other hand one should be able to use the graphical possibilities of DA's VECTOR for generating completely new forms of chart. After its generation a chart object is a completely normal group object, that may be edited and modified further with all the possibilities offered by DA's VECTOR. Even animated charts are possible with it.

As a preliminary one must create a table with numerical values and titles. This can be done in the integrated Table Editor, or in any desired ASCII text editor. One can also take in data from a spreadsheet or a data bank, since the format employed is widely used.

EXERCISE: A quick look at all chart types

STEP 1: Create table

First we have to fill the Chart Generator with data. As a typical example we want to show here something as simple as the election results of 3 parties (named Red, Green and Blue here) over 4 years — though somewhat more truthfully than usual in that the statistics do NOT suppress the percentage of nonvoters. (Just for fun, try something like this with 'real' election results; you will see quickly how the 'share' of the people's voice of the large parties suddenly looks quite different).

So go into the Chart Editor and call up the 'Enter data' input table. Here are the column- and line-titles and the numerical values that you have to enter:

Reds,	Greens,	Blues,	Nonvoters	
1994,	15,	25,	35,	25
1995,	12,	23,	32,	33
1996,	10,	20,	30,	40
1997,	8,	18,	28,	46

This format incidentally corresponds to the SFD format, which can be exported and imported. Such a (comma delimited) format can also be created quickly in a text editor or exported from a data bank or spreadsheet. With 'Insert Column' you must incidentally first insert two columns before you can input all these values. The 'party names' have to be entered in the first line (column titles), the dates in the far left column. Give the parties suitable colours by clicking on the colour patches under the columns and setting the appropriate colours in the colour selector dialogue. There is also a second input dialogue for charts in which other attributes such as scale, lettering (font, character size) etc. can be set. Choose first a suitable font and an appropriate character size. The other settings you can leave at first as they are and vary them later to suit your wishes. Once input has been completed no 'chart' will appear as yet; you first have to draw up a 'Chart frame' on the working area. Then a chart will appear immediately in the standard form (graph).

STEP 2: Graphs

This is the classical and simplest way to display the development of different comparative numerical values over a period of time. Few frills, but instead very honest and straightforward. Perhaps more suitable for people who want to understand numbers, rather than letting themselves be impressed by you.

STEP 3: Graphs with filled areas

If you click on the icon for 'filled graphs' (areas), then the region below the graphs will be filled with the corresponding colour. There are two different types of display available, which can be selected under chart attributes with the options 'Sum' or 'Absolute'. The 'Absolute' setting corresponds to the pure curve display except that the areas under them will be filled, and they may therefore mutually mask each other: Thus the display may indeed be 'honest', but not very useful if one cannot see some portions. With the 'Sum' setting the numerical values will be drawn as vertically superimposed areas for the individual dates, so at the bottom the proportion of Reds, above these the Blues etc. are shown. The total height of the area at any point represents the sum of the individual values. In our example (percentage election results) the total is always equal to 100 (%), so that the total value is always identical. With random numbers this is however not the case.

STEP 4: Bars

Click on the icon for two-dimensional bar display. This is the classic chart form, in which for each date (in our example) the various values (here the proportion of votes) are displayed next to each other as coloured bars of equal width and correspondingly different heights. Very lucid and clear and intuitively comprehensible.

STEP 5: 3D Bars

Click on the icon for three-dimensional bar display and then go into the '3D Chart Editor' sub menu for setting the 3D orientation (in space). With the two sliders you can bring the structure into the correct perspective. Furthermore you can set the illumination or shadow position by grabbing the small 'lamp' with the mouse cursor and moving it. An important hint here: The lighting effect is brought about by 'shadowing'. Therefore do not select pure colours (e.g. 0,255,255 for the 'Reds') for this type of display, but lightened colours (e.g. 0,127,127 for the 'Reds'), otherwise you will not get a true 3D effect with shading!

A graphic of this kind with 3D bars often looks very imposing, but is also often obscure, since the bars can mutually hide one another, so that only a little or reduced information is coupled with a lot of graphical work.

STEP 6: Pie Charts

Click on the icon for simple pie charts. Pie charts find favour above all for the display of percentage values. However they never contain absolute numbers, since the numerical values always represent their proportion of the total. Otherwise one would have to use differently sized pies, but that is not usual. Pie charts thus only show relationships, in our example what portion of the pie the various parties have attained.

STEP 7: 3D Pie Charts

Click on the icon for 3D pie charts and then go into the '3D Chart Editor' sub menu for setting the 3D orientation (in space). With the two sliders you can bring the structure into the correct perspective. Furthermore you can set the illumination or shadow position by grabbing the small 'lamp' with the mouse cursor and moving it. An important hint here: Here too the lighting effect is brought about by 'shadowing'. Therefore do not select pure colours (e.g. 0,255,255 for the 'Reds') for this type of display, but lightened colours (e.g. 0,127,127 for the 'Reds'), otherwise you will not get a true 3D effect with shading!

This pie chart display corresponds to the 2-dimensional one but just looks somewhat more imposing. If the text is partly covered by the pie charts, then you can easily correct this later (in the Vector Graphic Editor) by temporarily opening up the group (with a double-click) and 'bring the texts to the front' and also perhaps move them to suitable positions.

STEP 8: Free Area Diagram

For the next form we need a number of self-defined objects. Go first into the Vector Path Editor and fetch the triangle from the path library onto the working area. In the Chart Editor select the chart icon for 'Free objects'. In the chart attributes select the 'Sum' option. Now you still have to tell the program which graphic object you want to use for the individual parties. In this example we will take the triangle for all four columns. Click first on the assignment tool, then the corresponding row in the graphic and last on the graphic object. Repeat this for all the parties. Now the graphic consists of 4 groups each of four coloured triangles, whose area portions correspond to the numeric portions. In our case all four triangle groups have the same size, since all have the same total value (100%). With other examples the triangle groups might have differing sizes. When you use such simple area shapes, then the 'free area diagram' corresponds to proportional pie charts, where additionally the absolute values are also visible here.

Naturally you could also use different objects for the individual parties, but then the usefulness will be greatly limited since it is very difficult to judge the size relationship of different shapes.

In this exercise you will have noticed that the triangular areas in the diagram have taken on the colour of the relevant 'parties'. This will always be the case when one is dealing with simple path objects. As soon as you use more complex group objects, which may also contain several colours, then the object colours will remain unchanged.

STEP 9: Free Form Diagram

The 'Free charts' icon also hides another form of display. For this you now switch on 'Absolute' in the chart attributes. Now the objects will be built up in (four) rows behind each other in a kind of pseudo-perspective, whereby the absolute size of the objects (relative to one another) is retained. This type of display is well suited for use with a range of differing graphic objects. I had, for instance, a small library with animal figures, which illustrated the election results very nicely. If that is too cheeky for your purposes, you can also use 'picture objects' with photographs of the politicians, for instance. But personally I preferred pigs, geese, goats and hens..... Joking aside: With this chart form you can really do almost anything. Only your imagination sets the limits here.

STEP 10: Modifying charts

The Chart Generator doesn't deliver the desired optimum results in all cases. But after leaving the Chart Editor the presentation graphic is a quite normal graphic group that may be modified to suit your wishes. You can now put finishing touches to it to improve or modify the graphic. We want to show this here with a simple example, but the possibilities are really unlimited. Let's assume you have produced a simple bar chart. You can turn this simple form into a more attractive design, if, for instance, you back the bars with suitable fill patterns. With wood or marble structures the parties can be uprated properly!

To modify the graphic you can ungroup the group (and possibly any sub-groups) and modify the individual parts. A temporary opening of the group with a double-click is simpler, since this way the group and with that its structure is preserved. Otherwise it may happen that you afterwards have a heap of individual parts lying around on your working area that you cannot get together properly.

Naturally one can also do quite different things with such graphics. One can also batter the whole thing around over Bézier surfaces (that will make the parties less happy!) or animate the chart: There the vote proportions seem to grow towards heaven (that will make the parties much happier!).

Vector Goes Movie - The Possibilities

The Animation Editor of DA's VECTOR at first sight does not seem to offer all that many possibilities for one to dare to approach complex problems with it, but appearance deceives: Whoever on the one hand has comprehended the very simple principle, and on the other hand masters the multiple possibilities of DA's VECTOR, has opened to him undreamt of possibilities for creating slide shows and presentations, animation sequences, computer films, video titles, video shows etc. Even output to cine film is possible in principle (even though perhaps not necessarily economical due to lack of calculating power).

Basically one must here be clear about the application purpose before planning a project, since animation possibilities in a computer are still today subject to technical limitations with regard to real-time display. As long as one has at one's disposal the possibility to record single pictures (stop-motion video recorders, picture disk or 16/35mm in a slide writer or animation recorder) then there are virtually no limits to the application possibilities of DA's VECTOR. During design one therefore has to be clear in advance whether one wants to produce a 'computer film' or a computer presentation that can be displayed on the computer, or whether one wishes to create an animation sequence, a cartoon film, or video titles for recording onto video or film material (if one has access to means for recording a series of single pictures onto video or film).

In order to understand the limits, one has to be clear about the flood of data that originate from animation's: Let us quietly start from professional video quality, which can be realised on the FALCON030, for instance (with a few software tricks): Picture resolution in the PAL standard with 768 * 576 picture points in 64K colours (16 bit resolution); that's 442,368 pixels or 884,736 bytes of screen memory. At 25 frames per second this is already 22,118,400 bytes (around 21 Megabytes) of data. Today no PC-type of computer can create, move or decompress that in real time, or even load it from a hard disk, if the whole of the picture information is constantly changing. Luckily the picture contents of many animation sequences alters relatively little from frame to frame, and in the difference- or delta- compression method used also by DA's VECTOR only the picture differences between following frames are saved, then decompressed and drawn during replay. Whether an animation can be reproduced in real time therefore depends on the contents or the animation as well as the colour resolution and the picture size. Naturally the type of computer and graphic card also play a corresponding role.

Computer Films

For 'computer films' lower colour resolutions (say 8 bit) and also smaller picture formats are recommended. If possible one should renounce the use of sudden changes of colour for large areas, since for this large parts of the picture have to be altered simultaneously, and that takes a lot of drawing time. Besides true cartoons, animated illustrations, technical simulations and video titles for genlocked overlay one can also create simple slide shows and on-screen presentations. The memory requirements are usually smaller for these.

For replaying these computer films, DA's PLAYER program is used, which you may pass on freely with your animation's. The Player program can incidentally do far more that you can use at present: It can chain animation sequences invisibly and at the same time replay sound. For using these functions a special Script Editor is in the process of preparation.

Recording On Video

If one wants to record video films on the computer in real time then the same restrictions on colour resolutions and picture size apply as for 'computer films'. However dithered displays are less suitable for this (interlace flicker) and one should if possible use TrueColor display (15 or 16 bit). For home use one can often make do with a resolution of 384 * 288 pixels. However vector text will then often look very 'blocky'.

To achieve professional video quality one has to output the full 768 * 576 pixels of the PAL standard (depending on the pixel clock the line length may deviate slightly from the standard). And for such picture sizes you can naturally use real time animation only when the changes from picture to picture are not too complex. The only alternative (at present) is the recording of single pictures with the single-frame player. That of course assumes a suitable video recorder with stop-motion facilities, like some used for security applications etc.

The second main presumption is naturally a suitable graphic output, that is in PAL standard (or also S-VHS Y/C) (25/50 Hz frame/field frequency, 15.625 kHz line frequency) with sufficient colour resolution (15/16/24 bit TrueColor). 8 bit resolution is less suitable, since the 16.7 million colours are then dithered and with interlace this leads to unbearable flicker. If one does not have any other colour resolution available (as with many 8 bit graphic cards), then one should limit oneself to 384 * 288 (or also 768 * 288) pixels without interlace (but possibly then with 50 pictures/sec) recording.

A question often asked of our support service is: How do I get graphic output suitable for video? That naturally depends a lot on the computer type and any graphic cards that may be fitted. Though the ATARI computers can all output a picture according to the video standard as they stand, in most cases the colour resolution (only 16 colours) is unusable and with the disturbing black surround one really can't do anything sensible. Only the FALCON030 offers sufficient screen and colour resolution (even for professional use); in the so-called 'Overscan mode' the troublesome margins will then disappear, but unfortunately it seems that someone at ATARI USA has misunderstood the PAL standard and thus the operating system does not support the (quite possible) PAL resolution of 768 * 576 pixels. Since the video chip is freely programmable, this can be remedied by suitable software. The same applies when using the 'SCREENBLASTER' made by the Overscan company: Here too a very high video resolution is possible (832 * 576 without margins), but unfortunately in the existing versions the video frequency is not quite correct (Overscan has promised to remedy this). For all other ATARI computers a graphic card is imperative for a usable or even professional video quality. For this you should look for the following attributes: Colour resolution 15, 16 or 24 bit High/TrueColor; availability of 768 * 576 pixel resolution; timing adjustable exactly to the video standard; functioning VDI in HighColor or TrueColor mode respectively. Have the manufacturer or dealer confirm these attributes in writing before you buy.

All graphic cards deliver at their output only an RGB signal, which for recording on video has still to be converted to an FBAS (composite video including sync) or S-VHS (Y/C) signal. Such converters are available commercially with very varying qualities and even more varying prices. Only the FALCON030 offers a direct composite video output and so does not need an external converter. If you have fulfilled all the described preconditions, then with the aid of the two Players you can record animation's on video. You will discover that some manual work will still be necessary. But: Development continues...

Recording On Film

Basically it is even possible to generate animation's of cinema film quality with DA's VECTOR. The presumption for this is that somewhere one has access to a slide writer (exposing device) to which a 16mm or 35mm film camera may be fitted. With this one can directly expose the film frame by frame in very high quality (2000, 4000, 8000 lines).

One will most likely have to take one's data to a different computer system in order to output such recordings. The data format is no problem, since the Software of such exposing devices can practically always handle TIFF files. You therefore in this case do not output single frames as animation's, but 'print' them picture by picture to a TIFF file (3 colour!). So for this you fetch snapshot after snapshot onto the working surface and print each picture as a TIFF file in a corresponding resolution. These individual TIFF pictures will then be transferred to film in a service bureau. The amount of data (and with it also the calculation time) can become enormous: A colour picture with 4000 line resolution is over 32 MB in size! Whether the effort is worth while we cannot say. Faster computers and a direct connection to a slide writer with a suitable facility for a film camera could however make such an application quite interesting.

Understanding The Animation Process

One must understand the (in principle very simple) system on which the Animation Editor is based if one wishes to work successfully with the system: An animation sequence consists of as many tracks as you have defined layers (theoretically up to 64K). A track consists of up to 10,000 single pictures on which the various temporal states of an object (and ONLY ONE, which can however be a group object of any desired complexity) can be 'exposed'. Various states here mean: Differing size, position, shape and colour. The chief attraction consists in the fact that one does not have to expose (or draw) every single picture, but can store only certain steps in a transformation as so-called 'key frames'. The Animation Recorder (and the simulator) will then create suitable intermediate pictures automatically (by linear interpolation). The following limitation is important: Only the various states of one and the same object can be stored on one track; which changes of state are possible is discussed further below. If you want to use several objects in an animation then you have to create a corresponding number of layers (and with this tracks). The order of the layers also determines the mutual covering of objects where they overlap.

Now about the state changes of the objects: The essential thing is that the physical structure of the object is retained; it is quite permissible to first develop various phases of movement of a figure, store these individually in the clipboard and later copy them to suitable key frames. So different objects may be present by all means, which can be exchanged against each other, as long as they are structurally identical. Structurally identical means that the number of paths and the group hierarchy must not change. All other attributes may change.

The following attributes will be interpolated linearly: Position of each individual path point, including curve control points, and with this the shape, position and size of the object; line widths; line colour; area colour; fill pattern colour (for coloured halftone fill patterns); fill pattern size; fill pattern position.

The following attributes can be changed suddenly (abrupt switch): Colour/ transparency of lines, colour/transparency of areas, fill pattern picture; fill pattern fixing.

The 'snapshot technique' is unbelievably simple in operation: Position the object — snapshot as 'Picture X'; modify the object (or exchange it for a pre-prepared variation) — snapshot as 'Picture Y'. The other way round you can fetch every picture from the film clipboard again (by clicking on the 'snapshot' icon with depressed CONTROL-key) — and what's more not just the 'key frames' but also all intermediate interpolations, which you can modify again and turn into further key frames by snapshotting; in this way the 'flow' of movement can be refined step by step. The snapshot (in both directions) can either be restricted to the current track (active layer) or extended to all tracks (layers) simultaneously if one additionally keeps the SHIFT-key pressed. Such a vectorial animation sequence (consisting of an appropriate number of tracks with corresponding number of objects) can not yet be 'replayed' in real time — the calculation is too complex for this. In the simulator you can look at picture after picture in sequence, or at single pictures. To now make a playable film from this, the film has to be 'recorded'. For this a target resolution colour-depth and -structure, picture size) has to be pre-selected. The recorded film will only run in the appropriate resolution in each case. If one wants to have the film in a different colour resolution or picture size, one has to record it anew with the appropriate settings. Since one naturally always has the vectorial animation sequence available, one can 'record' a film any number of times in different resolutions.

This film recording consists of two steps: First the animation sequence is drawn picture by picture in the desired size and 'rendered' in the selected colour resolution. Following this a double compression process is applied, where in essence only picture differences are stored. The starting picture of an animation is always stored uncompressed. Here an important remark: At present you must always record WITH the start frame (picture) so that the Player receives a control file. Recording WITHOUT the start frame is only sensible for chained sequences. These can't be handled yet, but will be in the future when additional software becomes available.

The films recorded in this way can be reproduced in real time or frame by frame with the respective Players and then also recorded on video tape. For reproduction the animation is played 'from the hard disk' (virtually), thus loaded, decompressed and displayed blockwise. It can therefore be appreciably larger than the working memory. Naturally one has to respect the loading time. For a complex animation with a fluid display one should have a fast hard disk available. Furthermore large animation's should be stored on empty partitions so that the loading time is as short as possible.

Integrating Pixel Graphics And Pixel Fonts

However versatile vector graphics and vector text (with vector fonts) may be — at low resolutions the quality drops noticeably and is inferior to that of pixel graphics, particularly in the province of text. But there is absolutely no problem in combining pixel graphics and specially text with screen fonts (pixel fonts). Set such text in a monochrome graphic program and save the result in a Screen- or IMG-format. Load this picture into the PicConverter, convert it to grey scale and save it in 'TIH' format. Take this picture as a fill pattern of a vector frame and scale it (or the vector frame) EXACTLY so that later during output it will be drawn in a 1:1 relationship. Naturally you can also add any colour you like to this text, although the background will always remain white (in future, transparency will also be supported!). Alternatively you can also set the text on a coloured background in a colour graphic pixel) program, use monochrome text as a mask to set it on a colour photograph in a suitable picture processing program and then use this, and so on. Since you can adopt virtually all kinds of pixel graphics (after corresponding conversion) as fill patterns, no limits are set to your imagination here.

A special trick to obtain text copy with pixel fonts in various styles and character sizes consists of using a suitable text processor and corresponding snapshot software (such as Hardcopy with ALTERNATE-HELP) to store the screen picture as a graphic on a floppy or hard disk, and then undertake a suitable conversion.

Integrating Live Sequences / Pixel Animation's

Basically DA's VECTOR also offers the possibility to integrate live film sequences or computer films in the form of (rendered) pixel animation's with other elements (vector graphics, vector text, photographs). For this one has to create a special type of film track, that (in the simplest case) consists of a rectangular frame in the size of the working area (recorded area, also called 'page format') which changes its fill pattern from frame to frame. Naturally such a frame can also grow and shrink and fly around; then the animation will just fly through the screen...

The only further condition is that the individual film frames are available in the correct data format; this is aided in most cases by the Converter. How exactly you incorporate such animation or live film sequences will be explained with two simple examples (For this see also: EXERCISE: 'Construct picture-track'). In the first example we want to incorporate a live film sequence into the background. Let's assume that with the aid of a digitiser you have read in a sequence of 100 colour pictures (that is four seconds of video) and stored this in a suitable format (TIC for TrueColor pictures) or converted it to this format. Now load the track created in 'EXERCISE: Construct picture track' and replace all hundred fill patterns (or much simpler: Give the pictures suitable names from the start: PIC0000.TIC, PIC0001.TIC etc.). Now the live film sequence will be placed under your animation frame by frame. If one moves, scales, distorts etc. the frame then the live film sequence will be moved, scaled or its outline reshaped at the same time.

You can proceed in a similar way if you want to integrate pixel animation's that have been created with the programs CYBER series or PHASE 4 series or IN-SHAPE. Load these animation's first into CYBER PAINT or PRISM PAINT. From there you can save every individual picture in the DEGAS format and later convert this to the TIC format (those who possess DA's REPRO CD also into the space-saving TIP format). Such a picture sequence can be incorporated in the same way as described above for a live film sequence.

Titles For Videos

For titling videos one must have available a possibility of overlaying the graphic output of the computer over the picture from a video recorder or camera (genlock) and for recording the combination — at least if one wants to superimpose titles on live video sequences and doesn't want to restrict oneself to still pictures in the background (trailers). For this some form for 'stamping' (matting) out parts of the picture must exist, either analogue (mostly a black or dark blue colour) or via a digital signal (on the FALCON030 the 6th green-bit can be used for this). Basically a third possibility also exists, namely of purely digital composition. For this the complete video signal is digitised, incorporated as a live film sequence and overlaid with vector graphics and text, digitally 'recorded' and finally output (analogue) to video tape. Technically this is already quite possible; however, there is a lack of some software and hardware to carry out such a process with acceptable expenditure of time and work.

How you proceed to create a video title depends mainly on the hardware that you can use. All the regions that are later to be stamped or matted out from the video picture must be available in a suitable colour. The best way is to lay a track with a (suitable) single coloured area in the background. You then only have to take care that this special colour doesn't appear anywhere in the remaining graphic objects or text.

How you can use purchased genlock hardware together with the Player depends on the included genlock software. In case of problems please take the matter up with our support service.

Set Timing: Compress, Stretch And Move

There are basically two different ways of influencing the timing (passage of time) of an animation sequence subsequently. During the recording of the rendered images to disk the overall speed can be altered globally; you can select here the number of pictures per second and the total duration (within certain limits). Depending on the application one may have to reach a compromise here; in real-time applications above all the selected replay speed may often not be realisable (depending on the type of computer, graphic card etc.).

If one wishes to change the replay time of individual passages, this can be done with the track settings: 'Move', 'Stretch' and 'Compress'. With these one can move single frames or complete passages forwards and backwards, and with that modify the replay speed of the parts that were moved closer together or further apart; one can also stretch or compress passages and with that modify their replay speed relative to other passages.

EXERCISE: A simple slide-show

TASK: To create a simple slide-show with photographs or computer graphics; the pictures should simply be displayed full screen and change with geometric transitions. For this exercise you will need a few scanned or digitised halftone or colour photographs, or as a substitute some kinds of computer graphics (as pixel images), which naturally you have to convert with the PicConverter to the TIH or TIC format if necessary. The first slide-show effect you have to construct for yourself; then you can extend this show with the bundled examples (SHUTTERxx.HTT).

STEP 1: First lay out a 'Page Ratio' for your film. The absolute page size is not too important, but the proportion of the sides must correspond to the subsequent output size. Typical output proportions are 4:3 (e.g. 640 * 480, 768 * 576) or 8:5 (e.g. 640 * 400 pixels). Furthermore you should always position the page format in the centre of the working area and leave enough space around it that objects may be moved in any direction out of the picture. Some typical suitable page formats:

4:3 ~ XY-Pos. 250/300, W/H 300/225
8:5 ~ XY-Pos. 250/300, W/H 300/187.5

With a great deal of movement one can also use smaller page formats. This is only an example.

STEP 2: Go into the tracer by selecting 'Vectorising' in the 'Edit' drop down menu or with 'F1'. Import the desired photograph (halftone = TIH or colour = TIC). If you do not have any such pictures to hand, then take one of the fill patterns. Click once on the 'Create picture object' icon. It will appear inverted for an instant.

STEP 3: Go into the 'Vector graphic' menu. On the working area you will now find a rectangular frame with the photograph as contents (fill pattern). In the 'Area Attributes' sub menu switch the attributes for the fill pattern 'Rel' on and 'Fix' off. Move the picture object so that the upper left corner lies on the origin of the page (upper left corner) and scale the picture PROPORTIONALLY until it completely fills the page format. Now switch the fill pattern attributes 'Fix' and 'Abs' on. This is the end picture of the transition.

STEP 4: We will first store this end picture. For this we should consider how long the transition effect should last. Let's start with 25 pictures per second and a one second transition. So go to the Film clipboard, jump to 'Picture 24' (count starts from 0!), activate this picture by clicking on it and take a snapshot of it.

STEP 5: After being revealed the picture should remain in place for some time; after that a new picture should build up over the first until it completely fills the picture area; the first picture must therefore remain visible up to this time. Let's assume that the picture should be completely visible for 4 seconds (100 frames), then a new picture should appear complete within 1 second. That's a total of 125 frames. So in the Film clipboard go to 'Picture 149' (24+125) and take a snapshot.

STEP 6: Now only the actual transformation from the start picture (nothing visible) to the complete picture is missing. We'll choose here a simple 'expand from the centre': First position a horizontal guideline in the centre of the page and switch on 'Snap to guides'. Then move (with non-proportional scaling) the top edge of the picture object down to the centre line (it must snap to it). Then grab the lower edge and move this too to the centre line and let it snap in. The picture object now has a height '0'. This is our start picture. Go into the Film clipboard to 'Picture 0', activate this and take a snapshot. Now start up the simulator (with PLAY) and check the result in 'slow motion'. After Picture 25 nothing happens, naturally, and you can break off with STOP and QUIT.

RESULT: You have created the first slide-show transition effect. Save this as a track (HTT) so that you can use it again later. You can now add further slide-show effects with new pictures. For this you lay down a new track (layer) each time and add 25 frames from the end of one track to the next one. You can also load in one of the bundled shutter effects (SHUTTERxx.HTT) and move this back to a suitable position. You can then replace the pictures (fill patterns) in the key frames with your own ones.

EXERCISE: Construct picture-track

TASK: To construct a dummy track for playing live film sequences or pixel animation's. This exercise however only makes sense if you have access to some kind of live film or animation sequence that you can then incorporate. If you have the CYBER series of software you should be able to find a series of animation examples that you can (with some laborious handwork) adopt for this. If you do not have any kind of example to hand, then you can create one yourself from an animation in DA's VECTOR in the following manner:

For this choose a short animation from the bundled examples. Go into the Film clipboard and select 'Picture 0'; fetch Picture 0 onto the working area with SHIFT+CONTROL+left-click; select 'Print..' and in the following 'Output settings' dialogue the printer driver 'TIFF ColorBlock (File *.TIC)'; 'print' with 127 dpi at a 25% size to a picture file with the name PIC0000.TIC. Now select 'Picture 1' and repeat the whole process, where the file will now be called PIC0001.TIC. You've surely guessed it by now: You have to print the animation frame by frame to TIC files with successive numberings. For a pure simulation a short animation with 25 - 50 pictures may suffice. As already stated, the picture sequence produced in this way is only meant to serve as a substitute for an absent live film sequence or a pixel animation.

The following exercise represent a lesson in diligence, whose outcome can afterwards find many applications. Clever planning can save a lot of work later.

STEP 1: First lay out a 'Page Ratio' for your film. The absolute page size is not too important, but the proportion of the sides must correspond to the subsequent output size. Typical output proportions are 4:3 (e.g. 640 * 480, 768 * 576) or 8:5 (e.g. 640 * 400 pixels). Furthermore you should always position the page format in the centre of the working area and leave enough space around it that objects may be moved in any direction out of the picture. Some typical suitable page formats:

4:3 ~ XY-Pos. 250/300, W/H 300/225
8:5 ~ XY-Pos. 250/300, W/H 300/187.5

With a great deal of movement one can also use smaller page formats. This is only an example.

STEP 2: Go into the tracer by selecting 'Vectorising' in the 'Edit' drop down menu or with 'F1'. Import the first picture of the series (PIC0000,TIC). Click once on the 'Create picture object' icon. It will appear inverted for an instant.

STEP 3: Go into the 'Vector graphic' menu. On the working area you will now find a rectangular frame with the start frame of the animation sequence as fill pattern. In the 'Area Attributes' sub menu switch the attributes for the fill pattern 'Rel' on and 'Fix' off. Move the picture object so that the upper left corner lies on the origin of the 'page' (upper left corner) and scale the picture PROPORTIONALLY until it completely fills the page format.

STEP 4: Go into the Animation menu and call the 'Multi-Copy' function. Select as many copies as your animation has frames minus one. Copy without any kind of moving, enlarging, turning.

STEP 5: Go into the Film clipboard, activate 'Picture 1' and move the snapshot to the working area (click on it with CONTROL pressed).

STEP 6: Go into the 'Area Attributes' sub menu, load 'PIC0001.TIC' into an empty fill pattern field and activate it as a fill pattern for the object on the working area (object must be selected).

STEP 7: Go back to the Film clipboard and take a snapshot as 'Picture 1'.

STEP 8: Now you repeat STEP 5 to STEP 7 for each frame of the Animation sequence. This is really laborious work, which you can simplify if you make the constantly recurring functions into keyboard macros.

STEP 9: Control the result in the simulator (with PLAY). If all is well, 'record' the film in one of the resolutions available on your target system and take a look at it with the Player, since one can only check in real-time reproduction whether the timing is correct, i.e. whether the computer can (re)load and decompress the animation sequence fast enough.

RESULT: You have constructed a picture track that can reproduce (in principle any) picture series. In this manner, both live film sequences as well as already existing pixel animation's can be incorporated, combined with vector graphics, text etc. and then 'rendered' in any desired colour resolution and size for recording as a colour animation. You can use this 'track' naturally with different picture series, by simply creating various picture sequences with the same names (e.g. on interchangeable media). Such a 'picture track' can therefore be used repeatedly.

EXERCISE: Titling videos
TASK: To create an animated text for overlaying live video sequences in the genlock process. We are dealing here with a simple basic exercise that is only meant to illustrate the principles.

STEP 1: First lay out a 'Page Ratio' for your film. The absolute page size is not too important, but the proportion of the sides must correspond to the subsequent output size. For recording on video you need side proportions of 4:3 (typically 768 * 576 pixels). Furthermore you should always position the page format in the centre of the working area and leave enough space around it that objects may be moved in any direction out of the picture. A suitable page format is, for instance:

4:3 ~ XY-Pos. 250/300, W/H 300/225

STEP 2: Fetch the square from the Vector Path library and scale it freely to the size of the page area. Under Line Attributes select 'Transparent' and black for the area colour, or some other suitable genlock colour.

STEP 3: Go to the Animation Editor and there into the Film clipboard. Take a snapshot as 'Picture 0' and (depending on the length of the planned animation sequence, say) as 'Picture 75'.

STEP 4: Lay a new layer (and with it also track) over the background layer and activate this layer.

STEP 5: Go into the Vector Graphic Editor and there into the 'Vector Text' special menu. Create at first a simple line text in a suitable size and colour in a font of your choice. You can transform the text (by dissolving the group and renewed grouping or transforming into ONE path object) into a vector graphic object; however you should only do this if you want to undertake certain transformations (e.g. Bézier-mesh distortion) of the object for which the text object has to be automatically ungrouped, because you will degrade the quality of the characters (through loss of hinting). For safety's sake store a copy of the text object in the clipboard.

STEP 6: Go back into the Animation Editor and position the text below the active page area. Go to the Film clipboard and take a snapshot as 'Picture 0'.

STEP 7: Now move the text upwards into the page to around 2/3 height; if you want an exact movement, you should first set the directional snap to vertical and switch it on. Go into the Film clipboard and make a snapshot as 'Picture 49'.

STEP 8: Now choose the tool for proportional scaling and reduce the text object almost to a point. Push this object upwards slightly and perhaps to the left or right. Go into the Film clipboard and take a snapshot as 'Picture 74'.

STEP 9: Check the result in the simulator. The text characters should slowly wander into the picture from below until reaching the target height and then (with double speed) vanish backwards into nothing. If everything runs correctly in the simulation mode then you can record the title sequence to disk, and then with the Player and switched on genlock interface overlay it on a video recording.

RESULT: You have created a simple video title sequence. This still very simple version naturally may be extended in many ways: Multiple texts, also circle- and path-text, colour graduations in the lettering, texts with continuous colour changes with time, more complex transformations and movements, text appearing letter by letter (typewriter effect), text over fill pattern backgrounds etc. etc.... The possibilities are only limited by your imagination. And if you do not have genlock facilities you can simply place a scanned or digitised colour picture in the background (fill pattern in the background track) and so produce a video start- or end-title.

A quite important visual point for video titles etc. is the quality of the text: Don't use too small characters, since vector fonts in small sizes are never optimal. If at times you need very small characters then you must change over to pixel fonts (how that is done you will find elsewhere in this text). Record in the highest possible resolution; for main and end titles with a still background picture you can improve the text sharpness with antialiasing (pointless with genlock!).

EXERCISE: Flying objects - Refining movement
TASK: In this exercise you should make a 'paper dart' fly around in the area. This is intended to show the combined effects of various transformations and the step-wise refinement of movement.

STEP 1: First we need a suitable flying object. Its creation we will leave to you and your imagination. Don't try any flights of creativity; for this exercise a simple 'paper dart' is ideal. Build it up from simple (say triangular) vector areas (with different tones/colours!) and group them all into one object. Store a copy in the clipboard and go into the Animation Editor.

STEP 2: Now lay out a 'Page Ratio' for your film. The absolute page size is not too important, but the proportion of the sides must correspond to the subsequent output size. Typical output proportions are 4:3 (e.g. 640 * 480, 768 * 576) or 8:5 (e.g. 640 * 400 pixels). Furthermore you should always position the page format in the centre of the working area and leave enough space around it that objects may be moved in any direction out of the picture. Some typical suitable page formats:

4:3 ~ XY-Pos. 250/300, W/H 300/225
8:5 ~ XY-Pos. 250/300, W/H 300/187.5

With a great deal of movement one can also use smaller page formats. This is only an example.

STEP 3: First, should plan the flight path and position some marker points on the page area with (crossed) double guide lines. Place the 'dart' at the start position (which can be outside the page, if the dart for instance should fly in from the side), scale and turn it until it looks to you to have the correct shape and size, then in the Film clipboard take a snapshot as 'Picture 0'.

STEP 4: Move the dart to the second marked point and bring it to the appropriate size, position and orientation. Now take a snapshot as 'Picture 24'.

IMPORTANT NOTE: If one does a lot of transformation then it is often better always to start with the 'original' again. Throw the last object into the Trashcan in each case and fetch a copy of the original from the clipboard.

STEP 5: Repeat **STEP 4** for each further marker point. Depending on the distance between marker points and the planned speed or acceleration, also vary the time separation between the snapshots.

STEP 6: Take a look at this first step of the movement animation in the simulator. In most cases you will already recognise there that the movements are still 'angular' and also that the timing is not right. In cases of doubt just make a test recording (record in the current resolution to disk) and take a look at the result with the Player (call this under 'Services'). In the following steps of the exercise we want to show how one can refine such a movement course.

STEP 7: Let us assume, as an example, that the first part of the flight path (between Picture 0 and Picture 24 in our example) should be lightly bowed instead of straight. In the Film clipboard select 'Picture 12' and fetch it (click on the snapshot icon while pressing CONTROL) onto the working area. Correct the position (and perhaps the orientation) of the dart. Save the new position by a snapshot as 'Picture 12'.

STEP 8: Repeat **STEP 7** with Pictures 6 and 18. The position on these frames will have already been altered by the insertion of the altered Picture 12. Now both these intermediate positions themselves will be altered again. 3 intermediate points between the start and the (first) goal are often sufficient for a light bowing. For more strongly curved courses the number of intermediate frames can be raised further so that the course will be refined step by step.

STEP 9: Up to now we have only corrected the first part of the flight path. Now repeat steps 7 and 8 for all parts of the course. Make intermediate tests in the simulator and perhaps in test recordings to disk. Even when the course already runs smoothly you may often find that the timing isn't quite correct. This can be corrected in a further refinement step, as shown in the last part of the exercise.

STEP 10: Now finally the tempo inside the individual flight phases is to be modified. We will limit ourselves here again to the first part of the course. The others can be modified in the same way. Basically a change of speed in individual phases can be achieved by moving 'key frames' in time. That can be done manually (fetch the key frame onto the working area, delete it in the Film clipboard and take a snapshot at the desired new position) but it is easier with the track editing functions in the Film clipboard, as we will also do in this exercise. Let's assume that in the first part of the flight path (Picture 0 to Picture 6) the speed is to be doubled; then we must move Picture 6 to Picture 3. For this we could use the function: 'Move by .. To the Front' in the 'Animation Settings' dialogue, but that would alter the time relationship between the second key frame and the third (Picture 18); therefore we always move the complete rest of the animation, so: 'Move by 3..To the Front.. From Pic 6 to End Pic' is applied to the track.

In the second part of the flight path the speed is to be increased to 150% of the original speed, so that the distance to the previous frame must therefore be reduced from 6 to 4; from Picture 9 (the former Picture 12!) therefore the rest of the track is moved by 2 frames to the front. The next part of the flight path is to be run at the original speed (separation 6) so nothing is moved here. For the last part of the flight path the flyer should now take 50% longer: From picture 19 (= 24 - 3 - 2!) to the End Pic move 3 frames to the back!

Now you have probably entirely lost the overview of the position of the rest of your pictures. For a similar alteration to the remaining flight path you should thus first of all take a look where your key frames have now slipped to. In any case the simplest way consists of always activating the next key frame, then calling the dialogue for the move, afterwards activating the next key frame (that has moved again!) etc.

RESULT: You have produced a small, drawn stop-motion film with a flying object on a curved path moving at varying speeds. The individual values were chosen quite arbitrarily and the success of the exercise also depends on which flight path and what object alterations you have chosen. The first experiments will often not look very elegant. One needs a little feeling for the correct timing and that one only gets with increasing experience. In this exercise it was also intended to demonstrate an important principle: The step by step refining of the spatial and temporal movement sequences and transformations. This principle is usable in practically all means for creating animation's.

EXERCISE: Rotation

TASK: A graphic object should be turned with a fluid movement through 360 degrees. Here too we are dealing with a basic exercise that is intended to show the principles.

STEP 1: First we need a suitable object. Its creation we leave to you and your imagination. Naturally you can also load one of the bundled example graphics or fetch one from the library.

STEP 2: First lay out a 'Page Ratio' for your film. The absolute page size is not too important, but the proportion of the sides must correspond to the subsequent output size. Typical output proportions are 4:3 (e.g. 640 * 480, 768 * 576) or 8:5 (e.g. 640 * 400 pixels). Furthermore you should always position the page format in the centre of the working area and leave enough space around it that objects may be moved in any direction out of the picture. Some typical suitable page formats:

4:3 ~ XY-Pos. 250/300, W/H 300/225
8:5 ~ XY-Pos. 250/300, W/H 300/187.5

With a great deal of movement one can also use smaller page formats. This is only an example.

STEP 3: Position the object in the Animation Editor in the 'viewfinder region' (page format), so that it can be turned completely within the boudoirs of the page. You can also choose the turning centre now: For this set the turning centre at a suitable corner of the graphic with 'Snap to control points' turned on. In the Film clipboard select 'Picture 0'.

STEP 4: Now, (with the object selected), call the Multi-Copy function; here you set: 12 copies (plus original), 'Rotate' only active and with the angle set to '30ø'. Start the Multi-Copy by clicking on 'OK'.

STEP 5: In the Film clipboard you will now find 13 entries (key frames) from 'Picture 0' to 'Picture 13'. Since we don't want the turn to run as fast as this, we will still stretch the sequence created by the Multi-Copy. Call the functions for modifying the track and 'Stretch' by 400% from 'Pic 0 to End Pic'. Now the turn extends over 42 frames (which would correspond to a turning duration of 1 2/3 seconds at 25 frames/sec — naturally you can still modify the picture frequency while recording the output).

STEP 6: Check the result in the simulator and mak a test recording in the current resolution, in order to be able to test it by calling the Player (called from the 'Services' menu).

RESULT: You have produced 13 support frames for turning an object with the Multi-Copy function and the extended the animation sequence to the desired length; with some 12 intermediate steps the linear interpolations of the intermediate frames are hardly noticeable, and the turn appears nice and smooth. Naturally you can still improve the quality if you create more intermediate pictures by making copies with a smaller turning angle. With this exercise also we were mainly concerned with explaining a principle, which may be used in many ways.

EXERCISE: Animated transformations: Bézier crumpling

TASK: To modify objects with the Bézier transformation and use these modifications for free-flowing animation's. For this exercise you need some kind of suitable graphic object. We will make use of the DA logo from the library; naturally you can replace this with any graphic of your choice.

STEP 1: First lay out a 'Page Ratio' for your film. The absolute page size is not too important, but the proportion of the sides must correspond to the subsequent output size. Typical output proportions are 4:3 (e.g. 640 * 480, 768 * 576) or 8:5 (e.g. 640 * 400 pixels). Furthermore you should always position the page format in the centre of the working area and leave enough space around it that objects may be moved in any direction out of the picture. Some typical suitable page formats:

4:3 ~ XY-Pos. 250/300, W/H 300/225
8:5 ~ XY-Pos. 250/300, W/H 300/187.5

With a great deal of movement one can also use smaller page formats. This is only an example.

STEP 2: At first we want to prepare the transformations in the Vector Graphic Editor and make them ready for the animation process. For this we have to 'drive' the original object once through the transformation, for that will convert all straight lines into Bézier curves. That is namely what happens in all Bézier transformations, and the Animation Editor would object constantly if in one object phase the lines were replaced by Bézier curves but in others (the original) not. For this 'dummy' transformation use a rectangular Bézier surface that you size to suit the object. After carrying out the transformation the object should appear identical; only with a closer check will you find that all straight lines have been converted to Bézier curves. Save the object transformed in this way as a copy in the clipboard.

STEP 3: Now transform the graphic object into various shapes of your choice. You can do some experiments here until you achieve suitable results. You can continue to modify the object step by step, or always start afresh with the original object. Store each successful result in the clipboard.

STEP 4: You now have in the clipboard the original and some transformed versions. Clear the working surface and go into the Animation Editor. Fetch the original from the clipboard and position it on the working area (in the camera's view = in the page format). Take a snapshot as 'Picture 0'.

STEP 5: Throw the object into the Trashcan and fetch the first transformed object from the clipboard onto the working area. Take a snapshot as 'Picture 25' (just as an example, the timing naturally also depends on the type of transformation, but it can be altered any way you like afterwards).

STEP 6: Now repeat **STEP 5** for each transformation of the graphic object that you created earlier. At the end you should perhaps return to the original object; in that case just fetch this object from the library once more and save it as the last picture.

STEP 7: Test the results in the simulator and if necessary alter the tempo of individual passages by moving, stretching and compressing. Make a test recording to hard disk and check the result with the Player in real time.

RESULT: You have created an animation sequence with complex geometric (quasi three-dimensional) transformations. Here too we have used a simple example that is intended to illustrate the principle. As you will quickly realise, the Bézier surface distortion is a powerful aid in generating imposing animation's.

EXERCISE: Animated transformations: Formulae in action

TASK: This exercise is intended to show the use of the calculator and formula library in animation's and at the same time produce the first small application of the technique that can be put to good use by you and your fellow workers: You are namely going to create a film that uses the complete formula collection 'MATH_3D.DML' — quasi an 'empty' film for using this collection of formulae. For this take the DA logo from the library to serve as the start object.

STEP 1: First lay out a 'Page Ratio' for your film. The absolute page size is not too important, but the proportion of the sides must correspond to the subsequent output size. Typical output proportions are 4:3 (e.g. 640 * 480, 768 * 576) or 8:5 (e.g. 640 * 400 pixels). Furthermore you should always position the page format in the centre of the working area and leave enough space around it that objects may be moved in any direction out of the picture. Some typical suitable page formats:

4:3 ~ XY-Pos. 250/300, W/H 300/225
8:5 ~ XY-Pos. 250/300, W/H 300/187.5

With a great deal of movement one can also use smaller page formats. This is only an example.

STEP 2: At first we want to prepare the transformations in the Vector Graphic Editor and make them ready for the animation process. For this we have to 'drive' the original object once through the transformation, for that will convert all straight lines into Bézier curves. That is namely what happens in all Bézier transformations, and the Animation Editor would object constantly if in one object phase the lines were replaced by Bézier curves but in others (the original) not. For this 'dummy' transformation use a rectangular Bézier surface that you size to suit the object. After carrying out the transformation the object should appear identical; only with a closer check will you find that all straight lines have been converted to Bézier curves. Save the object transformed in this way as a copy in the clipboard.

STEP 3: Now you have to carry out step by step the individual transformations of the formula collection. For this fetch a copy of the original from the clipboard to the working area in each case, select the object, call the calculator and let it calculate the transformation. Store the results in the clipboard. Repeat this process for each of the 34 transformations.

STEP 4: You now have in the clipboard the original and 34 transformed versions. Clear the working surface and go into the Animation Editor. Fetch the original from the clipboard and position it on the working area (in the camera's view = in the page format). Take a snapshot as 'Picture 0'.

STEP 5: Throw the object into the Trashcan and fetch the first transformed object from the clipboard onto the working area. Take a snapshot as 'Picture 25'. Remove the object again, fetch a copy of the original and take a snapshot as 'Picture 50'.

STEP 6: Now repeat STEP 5 for each transformation of the graphic object that you created earlier. For this you will always alternate (at a distance of 25 frames) between a transformation and the original object.

STEP 7: When you have accommodated all the transformations, you should first make a test in the simulator. After this you should record the animation to hard disk; if you have used the DA logo then for this example a monochrome display will suffice, since the small teaching film is only intended to illustrate the mathematical transformations.

STEP 8: If you want to use this film as a demonstration of the formula collection, then for each individual transformation one must be able to recognise which one is currently being performed. So what is missing is some sort of labelling or at least numbering of the individual transformations. The execution of this task we will leave to your imagination. Just a few tips to start with:

Basically you have two possibilities to tackle this task: You can lay down all the required text phrases or numbers on a new track as a group, position this group first outside the page area and then move that text phrase that refers to the currently active formula into the picture, letting it disappear a little later. A second, more laborious alternative consists of constructing for each text phrase its own track; you can, for instance, superimpose the name for the duration (50 frames in our example) while each effect is displayed and let it vanish at the end. Technically this is very easy, but naturally you will need a further 34 tracks.

RESULT: You have created the first small teaching film that illustrates the use of the formula collection 'MATH_3D.DML' and at the same time learned to use the graphic calculator for animation's.

EXERCISE: Running match stick figure

TASK: To create a very simple cartoon in order to be able to practise the creation of phases of movement. A small match stick figure is to be given a running or walking movement for this.

STEP 1: First you need as a start object a small match stick figure (made only with lines, with no areas) in various movement phases of running or walking. In the first case try to manage with around 8 movement phases, possibly even fewer. Here it is difficult to give general rules - one learns mainly by trial and error. It is important, of course, that all movement phases be developed from the same basic object. Store all individual shapes in the clipboard.

STEP 2: Now lay out a 'Page Ratio' for your film. The absolute page size is not too important, but the proportion of the sides must correspond to the subsequent output size. Typical output proportions are 4:3 (e.g. 640 * 480, 768 * 576) or 8:5 (e.g. 640 * 400 pixels). Furthermore you should always position the page format in the centre of the working area and leave enough space around it that objects may be moved in any direction out of the picture. Some typical suitable page formats:

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With a great deal of movement one can also use smaller page formats. This is only an example.

STEP 3: Clear the working area and go into the Animation Editor. Fetch the first 'movement phase' (as a copy!) from the clipboard to the working area and take a snapshot as 'Picture 0'. Then throw the object into the Trashcan, fetch the next movement phase and take a snapshot as 'Picture 10'. Repeat this for all stored movement phases, at first with the same frame separations (around 10).

STEP 4: Take a look at the animation sequence you have created in the simulator. If you can find no gross errors, make a test recording to hard disk, since such movement runs can only be tested in real time. You will nearly always find that the first results are not very satisfactory; often quite a lot of detailed work is necessary to get a good reproduction of movements. Both the individual phases of movement as well as the timing (separation of key frames from each other) often have to be corrected. Keep on experimenting until you get an at least half-way satisfactory movement animation.

STEP 5: Finally you should let the match stick figure run through the whole picture. To do this you have to repeat the first part of the animation a number of times and in addition move the figure systematically in the running direction. That can be done manually or with the simple translation function of the calculator.lso use a trick that we will reveal to you here and which can serve you well in many cases: Export the first movement run (as soon as it looks acceptable) as a track (in HTT format) and load it in as often as you wish to repeat this run of movements. This creates a new track each time. Now move the sequences on the individual tracks back so that they fit together seamlessly. For instance: Your movement track went from Picture 0 to Picture 79 (80 pictures); move your first ADDITIONAL track to Picture 80, the second to Picture

For repetitions of the movement animation you can either fetch the individual pictures from the appropriate key frames, move them to their new position and take a new snapshot, or you can a 160 and so on. Now however you still have to move by hand (or with a suitable calculator function) the individual pictures in the additional phases you have loaded in the direction of movement.

RESULT: You have created the basic elements of a very simple cartoon, namely a running match stick figure. You can naturally extend this exercise by adding a background and further objects. In this exercise too we were not concerned with creating a perfect animation already, but just to learn the principles.