# COMPRESS FOR ACTION

**Gasp! at our explanation of data compression. Gulp! when we spell out those MPEGs. Swoon! as TIM FROST discusses how Digital Video works...**

MPEG, the encoding system used for putting film onto CDi discs, makes the impossible possible. First it manages to turn film into Digital Video, then it throws away 99 per cent of the digital signal and still produces video quality that matches the best that VHS can ever achieve.

When you turn film into Digital Video, you end up with a stream of electronic computer bits (ones and zeros) that spew out at the rate of 160 million per second. To get this onto CD means zapping enough of those bits out of the system to bring the numbers down to only 1.2 million every second - the rate that CD reads digital audio.

To develop a system of video data reduction was beyond the capability of any one company, so an international committee of specialists in moving pictures and sound was assembled, called the Moving Pictures Expert Group (MPEG). The MPEG committee involved 200 people from all areas - TV companies to computer games publishers - and devised an internationally agreed standard in 18 months.

## SO HOW'S IT DONE?

MPEG isn't one process. It's several, all strung together to create that enormous 99 per cent reduction in data rate. A lot of the techniques use some complex math which we will ignore as it all gets very complicated.

Instead, we will go through the whole process as though you were on a bit of film being turned into Digital Video.

First you are run through a special projector system with a built-in camera which transfers each of your frames onto a broadcast-quality Digital Video recorder. Now in tape form, you are fed into the MPEG encoder which is a high-powered computer with some extra image-grabbing hardware.

The system first reduces your broadcast-quality images to a more basic video quality, around S-VHS level, slimming you down by some 80 per cent but still making you look good on TV.

In the computer, your images are processed in two entirely separate ways. First each frame is looked at as though it were a single still picture. The system breaks your single picture down into small squares, each one eight pixels square (a pixel is the smallest single dot that the screen can display).

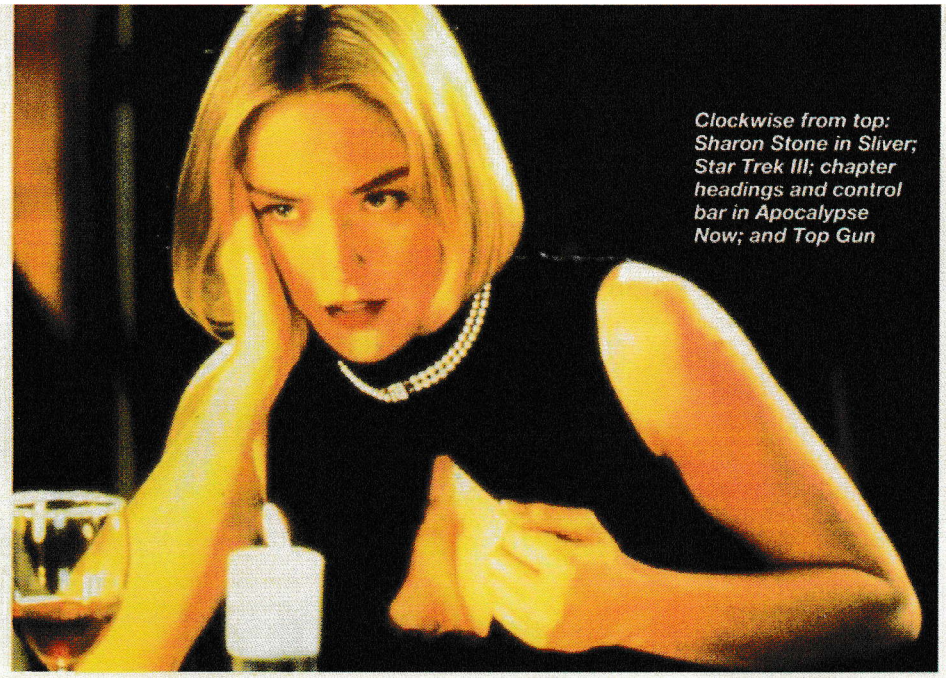
If the computer wrote down the colour and position of every dot in that square it would take up a lot of space. Instead, MPEG looks at the differences between pixels in the square. If it is a square covering a tiny part of your blue jacket, all the pixels may be exactly the same blue. The information then passed on about that square effectively describes the blue and says there are no other differences in that square. That takes just a few bits of data, compared with describing every individual pixel.

After that, MPEG starts looking at each of your frames in turn and compares little squares between frames. If you are not moving much, many of your squares remain the same from frame to frame and the MPEG encoder just sends a simple repeat instruction. Even if you are moving, many squares will remain the same but just change position. MPEG hunts those out and sends off a short instruction that says "repeat the square but move it a bit" - which takes a lot less computer data.

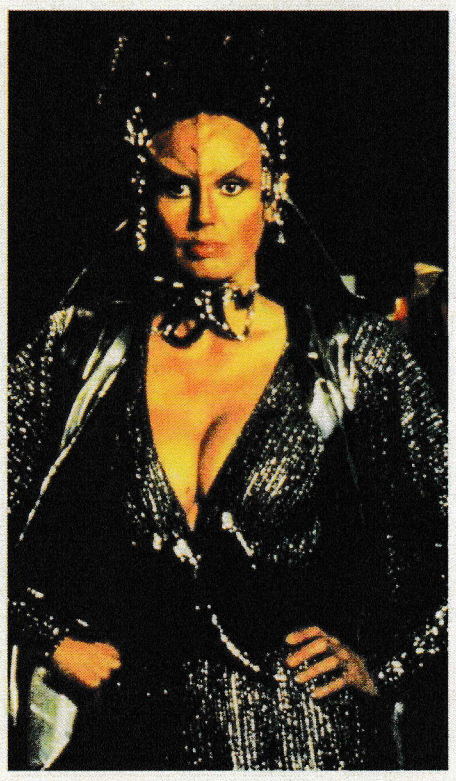
The system works impeccably until there is a lot of detail (in other words, until few squares are of just one colour) combined with a lot of movement (there are too many instructions to say what's moving where). At this point the system can run out of processing power and you have to make compromises.

One option is to soften you up a bit and make those edges less hard. Fewer hard edges means less variation within squares, and the single-image encoding becomes more effective. The other choice is intentionally to even out some of the data differences in each square. Your details are slightly less accurately described, but this does save on data. This means the squares now only approximate to your original look, and it becomes just possible to detect where one square stops and the next one starts.

The tricks that Philips and the film companies like Paramount are learning fast are how to transfer the



Clockwise from top: Sharon Stone in Sliver; Star Trek III; chapter headings and control bar in Apocalypse Now; and Top Gun




## THOSE MPEGs EXPLAINED IN FULL

What the Motion Picture Expert Group acronyms mean:

When we talk about MPEG for Digital Video, we are talking about only one of several MPEG standards that are being developed. CDi and Digital Video use MPEG 1, which is the first standard to be internationally agreed.

### *MPEG 1*

This is the system designed primarily for computer images, rather than TV use. A computer system uses 288 lines to build up each full picture. For film, each frame is scanned twice and the 24 pairs of pictures are sent off to the computer or TV screen. The sound system uses a stereo format almost identical to that used on Philips's DCC digital compact cassette. This can still produce surround sound as the stereo signal carries the Dolby Surround matrixed information.

### *MPEG 2*

As MPEG 1 developed, broadcasters realised that they would like a version developed primarily for TV work. The picture on your TV is made up of 576 picture lines, twice as many as the picture on a computer screen. TV transmits the odd lines (1,3,5...575) first, and then one fiftieth of a second later the even lines (2,4,6...576). When these are "interlaced" in between the odd lines, your eyes see the two sets as one complete image. This interlaced format needs slightly different ways of encoding the data. Broadcasters also want more than two audio channels, so the MPEG 2 spec includes six channels of discrete digital audio.

### *MPEG 3*

MPEG 3 doesn't exist. It was going to be the standard for high-definition TV, but work on MPEG 2 is going so well that HDTV is now part of that specification.

### *MPEG 4*

MPEG 4 is going to be the standard for getting pictures onto things like ordinary telephone lines or computer floppy discs. It is just coming under development now, and could lead to mobile video phones by the end of the century.

film to Digital Video so that when these compromises are made, they can't actually be seen.

That's where big improvements have been made over the last year. Early Top Gun clips were pretty dire. Now they're getting the hang of it, the finished production versions overtake VHS and move towards LaserDisc quality.

## WHAT IS DIGITAL VIDEO?

Are you completely baffled by the plethora of terms banded around in the wonderful new world of multimedia? Full Motion Video, Digital Video, Video CD and CD Interactive, to name but a few. What do they all mean?

***Full Motion Video:*** the generic term used to describe the process of digitally encoding full-screen video onto a standard 5 inch compact disc. The technique used is MPEG encoding. MPEG stands for the Motion Pictures Expert Group, an international body set up to set a standard for digitally encoding film and video on CD.

***Digital Video:*** Philips's own version of FMV. Early films and music videos released by Philips on the Digital Video (Green Book) format play on a CDi player with DV cartridge, an Amiga CD32 with FMV cartridge and a PC fitted with the ReelMagic MPEG board. The latest films are encoded to the Video CD format (see below) which makes them compatible with a much wider range of platforms. Each disc contains up to 74 minutes of film or video. This means most films are played on two discs.

***Video CD:*** the Video CD (White Book) standard has been formally agreed by a group of top electronics companies including Philips, Matsushita, Sony, GoldStar, JVC and Commodore.

Any Video CD disc will play back on a Philips CDi player with DV cartridge, Amiga CD32 with FMV cartridge and 386 PCs and Apple Macintosh computers equipped with CD-ROM XA drives and special MPEG video playback boards.

They will also run on dedicated Video CD players (a number of manufacturers are expected to introduce these later this year) and the 3DO system with FMV cartridge.

Video CD discs used with the correct player will play on all TV sets worldwide, including PAL, NTSC and SECAM. They can store up to 65 minutes of high-quality digital audio and VHS-quality video on a single disc. The discs will come in single, double or triple packs depending on running time.

***Compact Disc Interactive:*** this is the system developed by Philips to play games, films and music videos on all CDi players (fitted with a DV cartridge where necessary). The system will play all CDi discs, Photo-CD discs, Video CDs and standard audio CD discs when the player is connected to a hi-fi system.

***Photo CD:*** a system developed by Philips and Kodak which puts up to 100 high quality photographic images on a CD and lets you watch them through a TV. You can have a standard 35mm photographic film transferred to a Photo CD disc at selected high street developers.

## THE ARTEFACTS OF LIFE

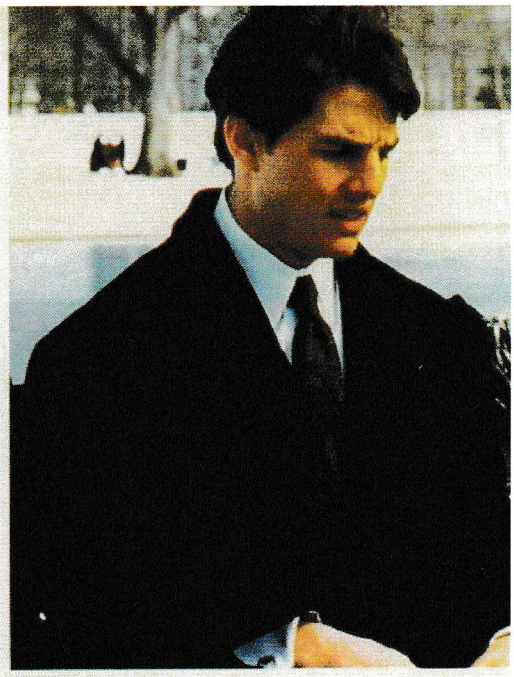
A full explanation of all those Digital Video wrinkles.

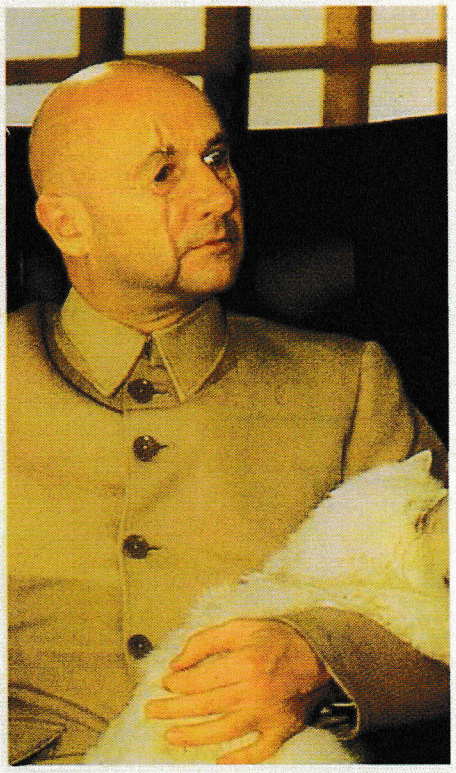
***Line structure:*** the MPEG 1 picture is made up of fewer lines, so on large screens and projection TVs the line structure is a bit more evident. In real terms the resolution is similar to VHS.

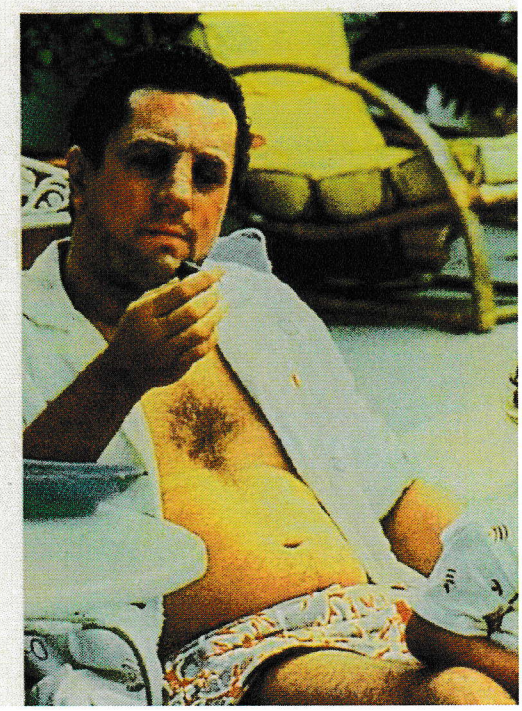
***Blocking:*** on some material it's possible marginally to detect the squares into which the picture is broken up. This is a very subtle version of the block effect used to disguise faces on investigative TV programmes.

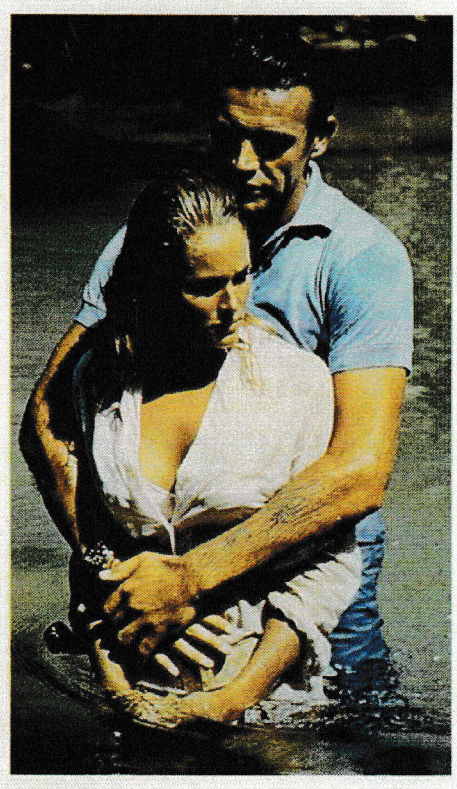
***Softness:*** lines in particular are not so clearly marked out. The picture is intentionally "softened" when film images carrying a lot of fast-moving detail are transferred to DV.

Blocking and softness are not normally present in the DV picture; they occur only when the images that are being processed contain a









huge amount of detail and are changing rapidly - pushing the MPEG 1 encoding system to its limits. This only happens for a very small part of the time.

*Judder:* moving objects on the screen seem to jump forward a little every now and then. Not strictly an MPEG 1 problem, this is seen only on Digital Video titles made for the US market, where pictures are encoded at 24 times a second.

*Left, clockwise from top; screen shots from The Firm, Dr No, Raging Bull and You Only Live Twice. Below: the Philips Digital Video cartridge, which makes playback of movies on CD possible*


## WHAT'S WRONG WITH VHS?

VHS suffers from its own roster of problems, which include chroma shift, head and tape wear, tracking problems, noise and dropouts, tape damage, variable duplication and lower resolution.

Once Digital Video disc and hardware production is in full swing, and everyone has worked out how to get the best out of the format, it will compare pretty closely to S-VHS on a good day and miles ahead of VHS when that is having a bad day. VHS's one overriding advantage, however, is that you can record on it.

## CONTROLS

Pressing an action button on the remote control or Touchpad brings up a control panel on screen reminiscent of a tape deck or VCR control panel. This provides access to the play all, fast forward, fast reverse, freeze frame, variable slow motion and stop icons.

The main menu provides a series of "chapter" headings which divides the film into sections. By clicking on any section, the disc will immediately jump to that part of the film.

This is a particularly neat feature which means you don't have to spend hours rewinding or fast-forwarding to find your favourite scene.

## WHAT'S COMING NEXT?

*Future developments*

The beauty of MPEG is that the picture is in digital "computer" code and it is possible to do all sorts of clever things with it. As the basic MPEG decoding deals with so much of the hard work, the cost of adding new tricks onto a DV player won't be that great.

Several improvements could be added to deluxe players in the future. Line-doubling, which creates new lines to fit between the 288 lines of the MPEG 1 image, would increase the resolution of the picture on large screens.

Real picture sharpening and enhancing is another possibility; so is adding in all sorts of video effects and colour changes.

Useful gizmos that will gain a foothold in the market will be the ability to zoom and create pictures-within-pictures. This last option will let programme makers show several views of a single event - say a football match with the conventional "chase the ball" coverage on the main screen, but with inserts from cameras behind the net and covering the full pitch.