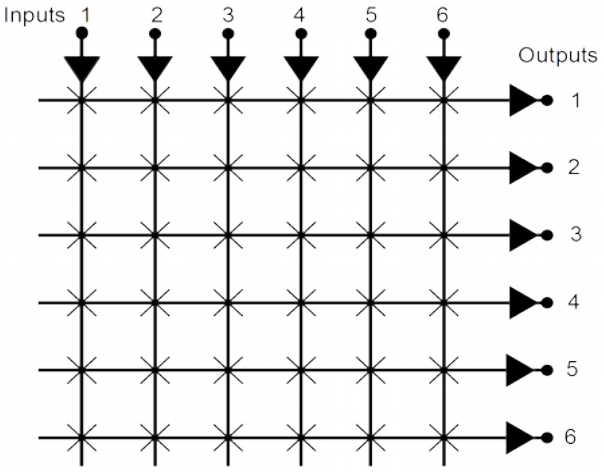
Video Fundamentals 11 Studio systems – the Matrix Brian Summers G8GQS

We have previously looked at cameras, monitors and mixers. This time I will explain about the Matrix (or router). I suppose the ancestors of the matrix were to be found in telephone exchanges. The earliest of these used jack cords to connect subscriber A to subscriber B and this evolved into the modern electronic exchanges having passed through the mechanical Strowger exchanges.

Video routing, and audio as well, used Musa and Jacks cords for this on large jackfields or patch panels. These became unmanageable in size and prone to faults & errors.

Relays were used in the first matrices arranged into rows and columns with a relay at each intersection which is called a “crosspoint”. Transistors and FETs replaced the relays and in turn they were replaced by integrated circuits.

In the figure is a small 6 x 6 matrix showing the principles features. Its worth noting that the size is a square factor i.e. a 20 x 20 matrix would have 400 crosspoints. The buffer amps ensure correct input & output impedances and no (or Very little) crosstalk.[1]



A 6 x 6 matrix with 36 crosspoints and buffer amplifiers on each input and output.

Control panels

A matrix needs control panels, these were often located near to the destination device, for example a video recorder would have a local panel that selected its input source. This was easy to do for a small matrix on a wire per function basis, 6 buttons, 6 lamps, 0v, +ve. fits conveniently on a 15 pin D connector. This all gets much harder for larger matrices. A 32 square matrix, with 1024 crosspoints uses a total of well over a 1000 wires even if you use a scheme to use the same wire for selection and bulb illumination. It is good practice to have the matrix illuminate the selected button lamp as a confirmation that the control action has been carried out.

It was not long before the control signals were multiplexed in some way to reduce the cable and connector size. RS232 was popular, as was systems using Co-ax cable. Co-ax was a popular choice as there is a lot of it in studios. At one time the BBC outside broadcasts used an audio tone system on Mic cable, this was called “Two-Max”. A common feature in control systems was incompatibility between manufacturers and even different versions of their own systems.

Master panels or X-Y panels

As matrices became larger and microprocessors came into use panels were developed that could select both the source and destination. It became possible to program different setup arrangements for different programs and the studio could be configured in a couple of button pushes, a powerful tool, indeed sometimes they could be locked with a key operated switch.



Button legends

Faced with a matrix panel, you need to know what the button you are about to press will select,

sometimes expressed as “what's under the button”. The easy solution was to have the button engraved with a legend, or to have a removable button top with a label beneath. When it became possible the next generation had small LED/LCD displays next to the button and latterly even an LCD display on the button top itself!

Multi layer or married matrices

It is easy to see the need for attaching audio to match the video selection, for stereo we now have a 3 layer matrix. This expands with increasing complexity to include, time code, cue signals, talkback, UMDs Data, extra program audio..... These could be “married” to all switch together or independently.

OCP[2] overrides

Another Matrix function is the OCP override, when the iris & lift control is pressed a closing contact drives the matrix to switch that camera to the engineers preview monitor. This is normally a secondary function of a local matrix control panel with a wider selection of sources. For Outside Broadcast practice, mixer-out might be the main selection and the OCP override allowing the selected camera to be compared with what is currently on the mixer.

UMDs[3] and Cues[4]

In front of the vision mixer there would be a number of preview monitors and if these are driven by matrix outputs with the cues and UMD names following it is easy to rearrange the layout at the directors whim.

Your Station

How might all this apply to your home station? Once you move away from the simplest set-up the profusion of wires and equipment becomes difficult to manage and the use of a small matrix, perhaps 8x8 makes switching easy. Does away with a lot of plug swapping!

Possible sources:- Camera 1, camera 2, Rx 1, Rx 2, VTR, mixer output, computer, captions, station ident, test signal, bars, test card, etc.

Destinations:- Transmitter, measurements, picture & waveform monitor, VTR input, big screen TV, computer grab, mixer I/ps 1, 2, 3.etc

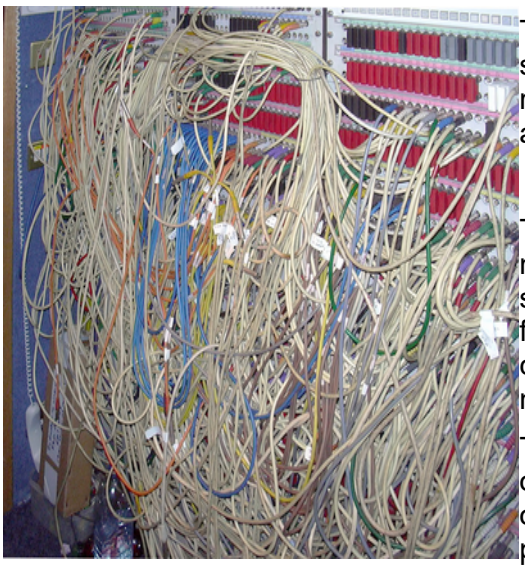
Matrix or Mixer?

A vision mixer can be considered to be a special case of a matrix and often has additional “aux” row outputs for monitoring but is a single layer just for the picture, sound being mixed separately. As mentioned above a matrix can have, and switch, many layers.

The Matrix in practice

In studio & OB use there has always been the need for switching and historically a combination of small-medium matrices with associated jackfields were used. In recent times very large matrices have been possible and sizes of 1024 square or even larger are possible with every signal going in and out of the matrix. At this point it is worth thinking about the practicalities of a 1024 square matrix having 1,048,000 crosspoints! Testing is an interesting prospect! The latest studio use is to move away from discrete video signals to IP based systems with big servers, but that is for another day..

A degree of complexity!



This is the video jackfield in a very large OB van at a major sports event. It gives some idea of the degree of signal routing and distribution required. All this was in addition to a 128 square matrix that was full!

The HD vehicle that replaced this one had a 1024 square matrix and a much smaller jackfield. With matrices of this size, a control panel with dedicated buttons was totally un-feasible, so the buttons you needed were assigned by computer and they had “soft” LCD tops that changed names and colours as required.

This 1024 square matrix was a monster that lived in it's own air-conditioned and soundproofed rack in the corner of the vehicle, if it stopped that was the end of your program.

No mention has been made of the type of signals; analogue, YUV[5], SD digital, HD digital, 4K, data, audio, all can be routed via appropriate an appropriate matrix.

This has mostly been about the broadcast applications of matrices but small ones can be of great benefit to the television amateur by adding additional system flexibility. Its also worth noting that PAL matrices are currently available a low prices on a popular auction site.

Brian Summers G8GQS June 2017

1 Crosstalk, in this sense the signal from the unselected inputs to an output.
2 OCP = Operational Control Panel
3 UMD = Under Monitor Display of the source details, Cam 1 or hoist or “Jim”
4 Cues or “Tallies” normally a Red cue but, depending on complexity, Green is used as well.
5 YUV a version of component video, luminance plus colour separation signals.