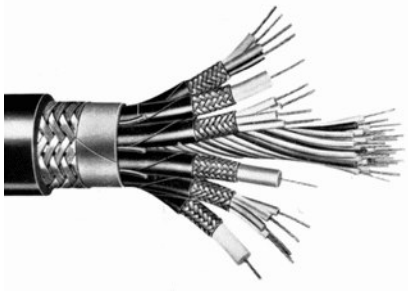
About Camera Cables

The recent live streaming events and the communication difficulties with the cameraman led me to an exploration of how camera cables began and were we are now.

The very first electronic television cameras, by necessity split the camera system into two parts, the camera head and the processing electronics with power supply. As technology developed more of the camera system was in the camera head, but the camera was still joined to the CCU (camera control unit) and PSU (power supply unit) by a thick multi core cable.
This cable had typically 37 conductors for a monochrome camera of the 1950s and early 1960s. These valve cameras used a "wire per function" with only a limited amount of doubling up of the controls, perhaps a DC function and an AC function would share the same wire. Talkback and shifts controls were favorites for combining.
The BICC Mk4B cable illustrated is typical of the period being used on Marconi, Pye & EMI cameras. It has a heavy rubber strain relief boot and the rear of the connector was potted in araldite, defiantly not rewireable but very reliable!



Mk4B cable cores



The Mk4B cable socket, the camera end.

It was preceded by Mk3 & Mk2 cables and before that the very first UK TV electronic camera, the EMI Emitron used a specially developed connector with 18 pins and two co-ax connectors.
It is worth listing some of the signals and circuits to be found in a camera cable. The 37 cores of a typical cable are soon used up! I should also state the obvious that the pins go to the CCU and the socket the camera.

<u>3 x Co-ax</u>
Video out
Line drive in
Viewfinder return

<u>3 x Quads</u>
AC power
Frame scan
Talk back
Cue Lights/ call cam.

<u>Pairs and singles</u>
HT+ 1, HT+ 2, HT-
Alignment and shift controls
Lens exposure servo
Turret and focus servo
Tube voltages

Colour cameras

The arrival of colour cameras posed a big problem and the first 3 tube ones used 3 monochrome cables to get the necessary number of circuits, they could be considered as 3 cameras in the one box. Later more practical cameras used cables with even more cores, the BICC G101 being a popular choice. 101 being the number of pins in the connector. These were expensive, heavy and sometimes fragile cables, especially on outside broadcasts. 2000ft of G101 colour camera cable would be 10 drums of cable, each drum being at least a two man lift! The chances of it working in the mud and rain were poor!



BICC G101 colour camera cable with fast thread for Marconi MkVII



A TV36 connector as used by Fernseh, Bosch & Link cameras

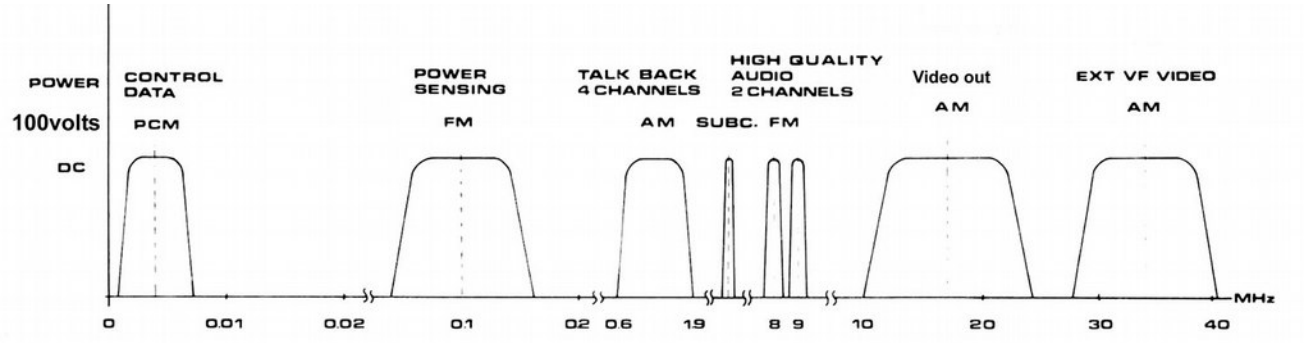
The next generation of colour cameras took a step back and used the earlier monochrome cables. There were two good reasons for this! First they could do it, the arrival of integrated circuits meant the multiplexing of controls was much easier and that digital control of systems was possible. In this way a single circuit could carry a digital word containing the data value for a particular function to be stored in the camera and the next word, with its address, a different control function. The second reason? There was a LOT of redundant monochrome cable awaiting a use and using it made your camera much more saleable! There were many other reasons as well but that has a certain ring to it….

Triax was the next big step forward

Technology came to the rescue again with a system called "Triax". This was a much simpler and lighter cable. Triax is similar to Coaxial cable, but with an extra overall screen. In the triax system the power for the camera is sent on the center conductor and the return on the inner screen as DC or AC in the 100 to 240 volt range. The outer screen being the safety conductor to maintain the camera body at earth potential. The pictures and digital control signals were carried on radio frequency carriers on the inner co-ax section. These much expanded digital control systems were developed from the previous generation cameras that used the monochrome cables. For OB use triax was marvelous, light, reliable and it went *much* further than multicore ever could, the Norelco PC-100 (LDK5) claimed 1 mile.



The Lemo Triax connector



This is the spectrum of a typical triax camera of one of the first triax cameras from the 1970s (LDK5). The power when to the camera at 100volts DC and the triax range was limited by the dc voltage drop and the falling off of the cable response at the HF end. The cameraman would complain his reverse viewfinder no longer worked! On important feature of this was radio working, by powering the camera locally the Data and video could go on radio links and "cable free" operation was possible.

Fibre

Today's HD cameras use a cable based on optical fibres. This has a connector that looks very much like a triax one, hence it is loosely called "fibre triax". It has 2 single mode fibres, 2 power conductors and 2 for signaling. It is light in weight and the length that can be used is governed by the voltage drop in the power conductors and the attenuation of the fibre joints. Lengths of 10,000ft are suggested and, with local camera power and few joints it has the potential for very long runs of cable. It does suffer the disadvantage that contamination of the fibre connectors will stop the camera working, scrupulous cleanliness is essential! Fibre is needed for HD cameras if any distance is required because triax is unable to handle the stupendous bandwidth involved. The HD digital camera has many, adjustments and nested menus that can be accessed through the viewfinder or more conveniently from the MSU (Master Setup Unit) connected to the camera via the CCU.



Lemo 3K.93C HDTV series



Close up of the near end. The fibres are the two white "pins"

The fibre is described in SMPTE specification 304M and more information can be found from the EBU. http://tech.ebu.ch/docs/r/r100.pdf

A second life?

As new cameras replaced old, there was a mountain of old cable looking for a new application and this was found in "on site vision" or OSV in BBC speak. Breakout boxes were made to go on the far end and the near end would connect to the OB van systems directly. This provided, all in the one cable, mains power, 3 video feeds, sound and talkbacks, a telephone circuit, and selector buttons for matrix control.

BBC outside broadcast made extensive use of BICC Mk4B cable and to a lesser extent G101 cable. It was so successful that when the cable wore out it was replaced with a purpose made cable with 7 co-ax cores and 7 quads for audio, this was known as Mk7 cable (from the number of circuits). There was a standard pin layout to ensure compatibility across the BBC. The ITV companies and BBC news used the same idea but with TV 36 camera cable.

What's needed?

It is worth thinking about what signals and controls are needed at the camera in a multi camera studio or OB setup and why.

Camera output.	**Obvious reasons**
Cue light/call camera	**You don't appreciate how important this is until you haven't got one.**
Production talkback	**To follow the directors instructions.**
Viewfinder return	**So that the cameraman can frame his shot with reference to the current shot on the mixer. V/F return could also be used to genlock the camera.**
Programme sound	**To follow the flow of the programme.**
Engineering talkback	**Separate from production talkback so that problems can be cleared whilst the programme is underway. This assumes you have the luxury of a separate engineering control area.**
Camera call	**Flashes a light/buzzer on the camera control panel.**
Camera reply	**To production or engineering as required.**
Iris control of the lens	**To make the cameras exposure match each other.**
Remote control of the filter	**A luxury to help with extremes of exposure control.**
Remote colour control	**To match the cameras so they look the same colour.**
Programme microphones	**Modern cameras have two quality circuits back to the CCU.**
A second return video	**Used for a prompt monitor or second V/F return.**
A power outlet	**Less common these days, good for a prompt monitor or similar.**

The above list is by no means exclusive and all to do with production use and I haven't started on the electronic controls, another long list. You can see why the camera cable is so busy and a vital part of the camera chain.

Brian Summers G8GQS 29 April 2009

Useful links
www.lemo.com
www.fischerconnectors.com

Notes;-
You may be interested to know the uncompressed bandwidths involved. In an SD (standard definition) camera the rec. 601 serial data rate is 270Mb/s and for HD (1080i) it is 1.485Gb/s. On copper it does not travel well at all.

SMPTE, Society of Motion Pictures and Television Engineers (USA)

If your OB van has a mall automatic telephone exchange, this can be a very useful communication tool.

There is some discussion in learned circles about the spelling of this word, in my book Program is something that is done to a computer and a Programme is something that you watch or listen to.