FINAL SCRIPT

00525/5228

VTC/6HT/72119

THE OPEN UNIVERSITY

TELECOMMUNICATION SYSTEMS

A THIRD LEVEL TECHNOLOGY COURSE

T.321/9

"Telephone Switching 2"

EXECUTIVE PRODUCER........................Nat Taylor

PRODUCER...................................Tony Jolly

PRODUCER'S ASSISTANT.......................Lesley Duncum

GRAPHICS...................................Sally Garner

SPEAKERS

Malcolm Hamer
Gaby Smol

OPENING TITLES

Sub-Title:

"Telephone Switching 2"

W/T

MALCOLM HAMER: This is a manual telephone exchange in which calls are connected by operators using a system of plugs and sockets. In the first part of this programme we're going to look at how this manual exchange works and to see what parallels can be drawn between the principles of operation of this exchange and those of an automatic exchange.

This is one of a pair of telephones which we brought over to this position on the manual board to demonstmate the operations involved in setting up a call between two telephones.

I'm going to go through all the operations involved starting with the caller lifting the handset of the calling telephone.

When the caller lifts his handset this

generates a call request signal which is sent to the Exchange and is detected in the line unit and this is signalled to the operator by a lamp being lit above a jack socket which corresponds to that telephone.

When the operator sees this she knows that a call is required so she goes to the supervisory units and selects a free one there are sixteen. I will use No. 9 the operator takes a plug from the supervisory unit and inserts this into the socket corresponding to the calling line. The operator then throws a key into the 'speak' position and this establishes a speech path between the calling telephone and her head set which she wears all the time, so the caller is then able to ask for the called line he wants. Lets suppose that the caller has asked for 378, that's the number of this other telephone. The operator takes the second plug corresponding to that supervisory unit and goes to this field of jack sockets and selects 378. The next thing she does is to test whether or not that telephone is busy, because it may have been connected to a, on another call by one of the other operators and to do this she touches the tip of the plug on the ring. If she hears a click in her headset this means that the telephone is busy, there is no click in this case so the telephone is free. She can insert the plug. The next operation is to ring the call telephone. To do this the operator throws this key into the ring position.

When the called user answers his telephone the speech path is then connected and the operators job for that part of the call is over. At the end of the call when the users replace their handsets clear signals are sent to the exchange and these are detected in the supervisory unit, so when the called user replaces his handset a clear signal is sent to the exchange and is detected in the supervisory unit and this is indicated to the operator by this lamp lighting. And similarly when the calling user replaces his handset the clear signal is detected and indicated to the operator by a second lamp lighting. When the operator sees both these lamps lit she knows that the call is over, so she can remove the two jacks.

And this supervisory unit is then free for use on another call.

Well those are the operations involved, before we look at the exchange in more detail let's see an operator doing all that at full speed.

Operator: "Number please"
Malcolm: "46 Dr. Jolly Please"
Operator: "Extension 46 Dr. Jolly I'll connect you"
Tony Jolly: "Tony Jolly"
Malcolm: "Just testing thank you"

Well although this exchange looks very different to an automatic exchange it is really functionally very similar and to show you this I am going to look at the various functions involved and relate these to the sort of functions in an automatic exchange you have been used to. An exchange can be thought of as consisting of three basic components. Signalling, control and switching. The signalling parts of the exchange receive signals from a user or from another exchange and pass these to the control and also receive signals from the control instructing signals to be sent out to a user or to another exchange. The control acting on these, the instructions received via signalling causes switching operations to take place in the switching network.

Well in this Manual Exchange here we have got just those same functions so lets look at signalling to start with. There are three pieces of signalling equipment. First behind here there's the line units which receive the call request signal from a calling line. Then secondly we have got the supervisory units which can send out the ringing signal and can receive the clear signal from the calling and called telephones. And the third piece of signalling equipment doesn't really look much like signalling equipment but it is, this is the operators headset because with this the operator can talk to the user, not just to chat about the weather though she can do this as well of course, but to receive address information. That is the required number of the called telephone, and so the means by which she does this is the ear piece of the signalling equipment.

Well of course the operator in this system is the control, she is a very interesting piece of technology, but she is basically doing all the things that a control does in an automatic exchange, that is receiving the signalling information and operating on the switching equipment using her hands. Now thirdly lets look at the switching equipment. The array of jack sockets here and the plugs associated with the supervisory unit form the switching network of this exchange and a jack socket into which she inserts that plug form a cross point so that the cross point is operated when she does that. So what we have here is effectively a 100 by 16 switching matrix which forms a concentrator. Now in this exchange there is no distributor but there is an expander and this is formed by the jack plug with which the operator calls a line and this same array of jack sockets, so when a plug is inserted here like this that is in fact forming a cross point operation in the expander.

So you see that this exchange although it looks very different from an automatic exchange, embodies the same functions as an automatic exchange although they're implemented just using a different technology.

Well lets turn our attention to the control again, to the operator, and look at some of the functions she's performing.

Operator: "Television Centre"
W/T

Malcolm: So I'm asking you to think of the operator as a control, receiving information over three internal signalling parts, one of these being from the calling lamps to her eyes, the second being from the supervisory lamps to her eyes, and the third being from the ear phone in her headset into her ear. And the information she's receiving from these three internal signalling powers, she's processing and she's then operating on the switching network using her hands to bring about the connection of calls. Well this control is very much more flexible than the sort of electronic or electromechanical control one might get in automatic exchange. For instance she doesn't have to be given the address information in the sort of rigid format which is required in an automatic system.

Operator: "Number Please"

Malcolm: "Dr. Jolly his extension is 4 something or other."

Operator: "Dr. Jolly he's on extension 46"

Malcolm: "Thank you"

Tony Jolly: "Hello, Tony Jolly"

Malcolm: "Just testing thank you very much."

W/T

Malcolm: Also the operator can provide a number of very advanced facilities requiring information storage and special translation of the address information.

Operator: "Number please"

Malcolm: "Extention 59 please"

Operator: "Oh do you want Dr. Jolly?"

Malcolm: "Yes Please"

Operator: "Oh he's in the OB unit I'll put you through now"

Malcolm: "Thank you"

Tony Jolly: "Tony Jolly"

Malcolm: "Just testing, thank you"

Malcolm: To do this sort of thing in an automatic system requires very sophisticated control equipment. And ever since automatic exchanges were introduced their designers have been striving to achieve the sort of flexibility that one gets with operator control. In public systems manual exchanges have been largely replaced by automatic ones, which achieve the speed and cheapness but sacrifices to some extent the sort of flexibility and personal service you get from the manual system. And the sort of space savings one gets with an automatic system aren't really that significant. However, in recent years with the introduction of electronics some of these drawbacks have been removed. So let's look at a prototype electronic exchange which goes some of the way to restoring the flexibility of operator service, and achieves quite significant space saving.

This part of the manual board serves about a hundred lines. So let's look at what the equivalent of this in an electronic exchange looks like.

GABY SMOL: This is it, just two boxes. The telephones are connected to the system. I'll dial number 102, so the call is established, well any exchange can do that of course, this exchange can do a lot more. But before looking at that let's see what the systems like. The telephones are digital, the speech signal is turned directly into a bit stream at the terminal. One of the boxes contains the switching and signalling circuits and the other contains the control. The control does the same job as the human operators we saw a moment ago. Well now lets look inside the boxes themselves. Everything is digital in the boxes, this circuit is the switching circuit just logic gates, this is synchronising circuits and these circuits are to do with signalling and supervision. Now the second box, this one, contains the control, I'll switch it off and I'll take out the main card. This main card contains a computer, a micro-processor which just takes up one chip, this is it, and all the other bits of circuit, all the other chips are memory circuits which are used in conjunction with the processor. Well having taken this out we've got to put it back again so in the meanwhile let's have a look at the signalling circuits and the switching circuits.

MALCOLM HAMER:
This diagram is an analogue representation of the digital exchange.

The local lines, of which there can be up to 256, each have an associated line unit to detect the call-request signal. The lines are connected to a 256 x 32 concentrator switching matrix which gives them access to any one of the 32 supervis units. A register may be associated with a call during the dialling phase by means of an access switch. The other side of each supervisory unit is connected to an inlet of a 32 x 256 expander matrix, whose outlets are connected to the local lines.

Because the signals from the telephones are digital, the design of the switching and signalling equipment can be made much more efficient than an analogue arrangement like this by the use of time-sharing techniques. Let's consider switching first. How can we switch digital signals?

Well, one possibility is to use a simple matrix of electronic crosspoint devices, such as AND gates. This switching network is just like an analogue switching network except that signals can only pass in one direction through the network, from the incoming channels to the outgoing channels. The complete switching network would therefore consists of two networks like this one.

Of course in practice we would use a multi-stage network rather than a single matrix, so as to reduce the number of crosspoints. But we can achieve a much more remarkable reduction in the number of crosspoints by time-sharing them between a number of concurrent calls.

In this switching network bits, or groups of bits, from each incoming channel flow into a buffer, and are then switched through the network at a much higher bit-rate than that of the local lines. So, the crosspoint matrix, which is calle the space switch, has its crosspoints time-shared between a number of calls. The switches associated with the buffers are called time switches.

You may have recognised this switching network as being similar to that of the digital trunk exchange shown in the course book.

In this case the incoming highways carry the signals of a number of speech channel in multiplexed form, so the incoming time-switches incorporate demultiplexers, which deliver the bits corresponding to individual speech channels into separate buffers. On the outgoing side of the network the channels are remultiplexed onto the outgoing highways.

In this type of time-space-time switching network it's possible to vary the proportions of time and space switching. Let's look at the extreme case where all the time switches share a common highway.

Here there is no time switching at all. In this case the bit-rate of the common digital channel is the bit-rate of the individual speech channels multipled by the maximum number of calls to be switched by the exchange. For large exhanges this extreme case is impractical because the finite speed of operation of electronic circuits limits the bit rate of the common channel and hence the maximum size of the exchange.

However, for a small local exchange this limitation is not a problem, so this approach can be used.

This is the switching network of the experimental digital exchange we have been looking at. In this case individual local lines are connected to the switching network, so no demultiplexing or remultiplexing is required.

Let's go through the operation of this network, representing the binary signals by 0s and 1s. We'll concentrate on the top and bottom lines and follow a few bits from these through the network. I this particular design, switching is bit by bit, so during each local lin time-slot just one bit passes into buffer. A switching cycle then c A switching cycle occupies one l time slot. Let's suppose that incoming channel is to be connected to this outgoing channel. During the first common highway time slot this switch and this switch operate, so the bit passes over the common highway to the outgoing buffer. During the next time-slot the bit from the next buffer can be transferr in a similar way, and so on.

Let's suppose that the bottom channel is to switched to this outgoing channel, so this switch and this switch operate, and the bit passes into this buffer. The bits fr all ongoing calls are thus transferred during one switching cycle. That cycle took exactly one local line time-slot, so the next bits now move into the buffers. The swi ching cycle is then repeated, so these bits are transferred to the outgoing buffers. As this is happening the previous bits flow out onto the outgoing channels.

Similarly, the next bits are transferred in the next switching cycle.

So, the result of this switching process is that bits flow in a continuous stream into and out of the switching network, even though the transfer of bits through the network takes place in a number of short bursts.

That's how the switching is done. Now let's look at signalling. The local line signals consists of groups of 9 bits, eight of which represent a pulse coded speech signal sample, and the ninth of which is a signalling bit. Each local signal consists of an eight bit signalling word. The signalling bits pass over the common highway in the switching network, along with the speech bits, so they can be monitored there by a few time-shared signalling units: one f for each signalling function.

This is the complete structure of the switching and signalling equipment.

In this diagram I've shown both switching networks: one for each direction of transmission. The speech signals for a call pass from the incoming channel of one telephone, through a time switch, over the forward highway, through another time switch, to the outgoing channel of the other telephone. The signals from the incoming channel of this second telephone pass through a time switch, over the other highway, the backward highway, through a time switch, to the outgoing channel of the first telephone.

The signalling units are attached to these two common highways. There are just four signalling units: a line unit, a register, and two supervisory units: one for detecting the clear signal from the calling telephone and one for detecting the clear signal from the called telephone.

Because the register and supervisory units are connected to the common highways they can monitor the signalling bits which appear in every ninth switching cycle. The line unit works slightly differently, it monitors one common highway time slot to which the lines which are not in use are switched one after another in rotation.

So by being connected to the common highways the signalling units have access to all signalling information on a sequential basis.

Now let's look at the signals on one of the common highways.

We'll consider two eight-bit speech words for two ongoing calls. The first bit of call no. 1 appears in one of the common highway time-slots, and the first bit ofcall no. 2 appears in another time slot, the second bit of the two calls appear in the same time slot but one cycle later and so on. So each cycle contains one bit from each cycle. The duration of each switching call is 13.9 microseconds.

GABY SMOL:
This is the bit stream for the forward common highway, I've only got two channel showing in time slot one and time slot four. This pulse represents a bit on channel 1 followed by a bit on the second channel. After a complete cycle we get the next bit for channel 1 followed by the next bit for the 2nd channel. There are 32 time slots available in a complete cycle from here to here so we can have up to 32 channels on this system. I can add a few channels using the controls on the exchange, this is adding channel time slot 11 and this one is another channel on time slot 20.

Well that's what the bit stream looks like. Now let's see some of the things the system can do. Let's imagine that 102 is engaged talking to somebody, if I phone 102 I'm going to get the busy signal, so I phone star 2 and put my phone down. Now let's see what happens when 102 finishes his call, So the call is established. What happened then was that as soon as 102 finished the exchange called me up to check that I was still there and then established the call that I'd asked for previously.

Now let's look at another facility, let's imagine that 102 wants to be able receive calls when he is in his office but when he is out of his office he'd like the calls to be transferred to 103. What he does is to dial star 31 followed by 103 and then puts his phone down. Now if I phone from this phone, 102, well it rings in 102's office for 4 seconds then it switches to 103. So the call is established to 103.

Well this system has got many advantages it's very compact it can handle several hundred lines and this is a prototype, the production model will be a lot smaller

Also it's entirely digital. Now this means that one could replace a telephone terminals by fast data terminals. One could therefore use the same system for both the fast data network and the telephone network. Also of course it's very flexible because one can change facilities just by changing the computer programme. However, there are some things which a human operator can do which it might not be able to do. Consider for instance what would happen if 103 wanted to transfer his calls to 102 and didn't know that 102 had already got his calls transferred to 103.

END CREDITS

The speakers were
Malcolm Hamer
Gaby Smol

Facilities
The General Electric Co. Ltd.
HIRST RESEARCH CENTRE

Plessey Telecommunications Ltd.

Production by
Tony Jolly

A Production for the
Open University BBC-TV

T321/9

CAMERA SCRIPT

FRIDAY 27th FEBRUARY 1976

FACULTY NO: T.321/9

STUDIO 'A' A.P.

PROJECT NO: 00525/5228

VTC/6HT/72119

THE OPEN UNIVERSITY

TELECOMMUNICATION SYSTEMS

"Telephone Switching 2"

Senior Producer...Nat Taylor
Producer/Director.......................................Tony Jolly
Vision Mixer..Mig Harper
Floor Manager...Tony Guyan
Make-up Assistant.......................................Martha Livesley
Graphics Designer.......................................Sally Garner
Designer..Bernard Lloyd-Jones
Producer's Assistant....................................Lesley Duncum

Technical Manager.......................................John Fane
Sound Supervisor..Jerry Lawrence
Senior Cameraman..David Wilson

PRESENTERS

Malcolm Hamer

GARY SMOL

SCHEDULE

1030 - 1300 ....Rehearsal
1300 - 1400 ....Lunch
1400 - 1430 ....Line Up
1430 - 1715 ....Record Edit (Editec)
1430 - 1500 ....Insert on TK
1430 - 1715 ....Episcope
1430 - 1715 ....Insert on VT

TECHNICAL REQUIREMENTS

CAMERAS:	
1	PEDESTAL
2	PEDESTAL
3	PEDESTAL
SOUND:	1 Boom Long-lead Headphores for cap. ops.
TJ's by 1015	
FLOOR MONITORS:	Special
VTR.	Record(Editec) 1 machine 1430 - 1715 90' tape Insert from 1430 (1 machine)
TK:	1430 - 1500
EPISCOPE	1430-- 1715
INLAY:	1430 - 1715
ELECTRICAL SUPPLY	Yes
CAPTION STANDS	Two

(ON VT) SOUND ON TAPE

DEPARTMENTS WITHIN THIS FIRM MEET TO DISCUSS MATTERS CONCERNING THE RUNNING OF THE PLANT. /

TK. 1

Duration 00'11"

SOUND ON TAPE

THE FIRM, WHICH SPECIALISES IN ELECTRO-PLATING VARIOUS PRODUCTS, EMPLOYDS FOUR HUNDRED PEOPLE IN SMETHWICK, AT THE HEART OF THE INDUSTRIAL MIDLANDS. /

VT

SOUND ON TAPE

INSIDE THE ATMOSPHERE AND APPEARANCE IS SIMILAR TO MANY OTHER FACTORIES WITHIN THE ENGINEERING SECTOR. HOWEVER SINCE 19[illegible] A SYSTEM OF EMPLOYEE PARTICIPATION HAS OPERATED WITHIN THE COMPANY. THIS HAS ALTERED THE WAY IN WHICH DECISIONS ARE TRADITIONALLY TAKEN BY MANAGEMENT.

THE PARTICIPATION SCHEME, WHICH IS LINKED TO AN INCENTIVE BONUS PLAN, CENTRES AROUND THE COMPANY COUNCIL.

THE COUNCIL MEETS EVERY FORTNIGHT AND ALL REPRESENTATIVES ARE FREE TO RAISE ANY MATTERS THEY WISH.

IN THIS PROGRAMME THREE PARTICIPANTS IN THIS SCHEME EXAMINE THEIR ATTITUDES TO PARTICIPATION AND THE EXTENT TO WHICH TRADITIONAL VALUES ARE CHALLENGED.

FADE TAPE SOUND

FADE UP VT SOUND

JOHN ELLIOTT

Some people have suggested to me that could the actual figure of profit be put on the sheet alongside whatever figure we have made or lost, because as you said before a lot of people were surprised - higher up the scale of management, they were more surprised than what I was...

DAVID WESBURY

Paul came along last month and said to Janine - O.K. the firm was over £6,000 in loss, but I bet the company did O.K.

JANINE WYNNE

£15,000 was what he said.

TJ LIST

SHOT NO.	TJ NO.	DESCRIPTION
2A	1	"Telephone Switching 2"
4B	2	"Concentrator"
4C	3	"Concentrator and Expander"
4	4	"Concentrator/Expander and Loop Connection"
23A	5	"The Speakers were Malcolm Hamer Gaby Smol"
23B	6	"Facilities The General Electric Co. Ltd. HIRST RESEARCH CENTRE Plessey Telecommunications Ltd.
23C	7	Production by Tony Jolly
23D	8	A Production for the Open University BBC-TV (c) The Open University 1976

CAPTION LIST

SHOT NO.	CAP. NO.	DESCRIPTION
3	1	"Block Diagram of PBX"
7	2	"Block diagram of Digital Exchange"
10	3	"Switching Equipment for Digital Exchange"
17	4	"Signalling Word"
18	5	"Switching Circuit for Digital Exchange"
19	6	"Line and Highway Signals for Digital Exchange"

PROF. A NOVE:

it was essential to maximise food production?

4. 1 A MCU Nove — /UNSCRIPTED (APPROX 45") /STUDIO/

ZOOM IN TO CU

5. 2 A Cap.3 Peasants — /Today in the 1970's, about 30% of the Soviet people still live on the land; but there are no longer small peasants. Soviet agriculture has been collectivised. The Collective Farm and the State Farm account for most Soviet agricultural output.

/S/B TK/

6. 1 A MCU Nove — /As the next bit of film suggests, the official view is that the problems faced by Lenin have now been solved - at least on this farm in Uzbekistan.

/RUN TK/

7. TK2 (DUR: 2'27") — /COMMENTATOR: /S.O.F./

Every year the farms assets expanded and the amount of machinery and fertilisers grew. The crop yields also increased. The expense incurred in the purchase of machinery soon paid for itself. Spring is a busy time for all of the farm's workers. The machinery must be checked, seed prepared and sowing must be done quickly and on time. Each farmer has a home and a plot of land for personal use. This is the farm's Board, the Executive elected by all members of the Collective. The Board's Chairman is Ordilov. He too was elected. The Board plans the further development of production, discusses the results and criticises shortcomings. Its decision is then discussed and,

(1 NEXT)

RUNNING ORDER

SHOT	PAGE	DESCRIPTION	CAM	SOUND	TJ'S	CAP.	DUR. REC.
1	1	TK Opening Titles		O.F.			
2-2A	1-10	VT Seq. + Sub-Title		O.VT	1		
5-10	10-11	Digital Exchange	All	Boom		2/3	
11-16	11-12	Episcope		Boom			
17-20	12-13	Signalling	2/3	Boom		456	
21-23	14-15	Processor	2/3	Boom			
23A-D	15	Closing Credits	3	Boom	5-8		

(3 58)

MOHOLY-NAGY (contd.):

During the Thirties he had continued to explore the behaviour

53. 1 A — Light Box (12) - Constructed with Pins

of light in his/ abstract works. This composition of 1936 is constructed of perforated zinc and glass-headed pins. His

54. 2 A — Light Box (13) - CH2

later paintings/ show a movement away from the geometrical forms of the twenties. He began to explore the possibilities of the

55. 1 A — Light Box (14) - Plexiglass sculpture

new/ translucent plastics, which could be bent into sculptural

56. 2 A — Light Box (15) - Zweiton

forms, and used to create/ moving shadows behind the painted surface. The later colour photographs

57. 1 A — Light Box (16) - Car headlamps 1

use/ light sources such as traffic headlamps to produce pure patterns.

MOHOLY-NAGY:

We have now reached the stage when it should be possible to discard brush and pigment and to

58. 2 A — Light Box (17) - Car headlamps 2

'paint' by means of light/ itself. We are ready to replace the old two-dimensional colour patterns by a monumental architecture of light.

(3 IMMEDIATELY NEXT)

/VT CLOCK/

/S/B TK/

/RUN TK/ /S/B VT/

1. TK (Dur: 17") /S.O.F./
OPENING TITLES

W/T

/RUN VT/ (CSO at end of film)

/S.O.VT/

2. VT (Dur: 10'23") /
OB of PBX A.P.

S/I

2A. TJ 1
"Telephone Switching 2"

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When the called user answers his telephone the speech path is then connected and the operators job for that part of the call is over. At the end of the call when the users replace their handsets clear signals are sent to the exchange and these are detected in the supervisory unit, so when the called user replaces his handset a clear signal is sent to the exchange and is detected in the supervisory unit and this is indicated to the operator by this lamp lighting. And similarly when the calling user replaces his handset the clear signal is detected and indicated to the operator by a second lamp lighting. When the operator sees both these lamps lit she knows that the call is over, so she can remove the two jacks.

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3. ______________________________/ Signalling, control and switching. The signalling parts of the exchange receive signals from a user or from another exchange and pass these to the control and also receive signals from the control

CAP 1
in at (4'24" into OB Seq.)

CAP. 1

instructing signals to be sent out to a user or to another exchange. The control acting on these, the instructions received via signalling causes switching operations to take place in the switching network./

Out at 4'53" into OB tape

Well in this Manual Exchange here we have got just those same functions so lets look at signalling to start with. There are three pieces of signalling equipment. First behind here there's the line units which receive the call request signal from a calling line. Then secondly we have got the supervisory units which can send out the ringing signal and can receive the clear signal from the calling and called telephones. And the third piece of signalling equipment doesn't really look much like signalling equipment but it is, this is the operators headset because with this the operator can talk to the user, not just to chat about the weather though she can do this as well of course, but to receive address information. That is the required number of the called telephone, and so the means by which she does this is the ear piece of the signalling equipment.

Well of course the operator in this system is the control, she is a very interesting piece of technology, but she is basically doing all the things that a control does in an automatic exchange, that is receiving the signalling information and operating on the switching equipment using her hands. Now thirdly lets look at the switching equipment. The array of jack sockets here and the plugs associated with the supervisory unit form the switching network of this exchange and a jack socket into which she inserts that plug form a cross point so that the cross point is operated when she does that. /So what we have here is effectively a 100 by 16 switching matrix which forms a concentrator. Now in this exchange there is no distributor but there is an expander/and this is formed by the jack plug with which the operator calls a line and this same array of jack sockets, so when a plug is inserted here like this/that is in fact forming a cross point operation in the expander./

S/I (lower third)

4. TJ 2
ANIMATED TJ Sequence

In at 6'35" into VT tape

TJ 3
"Concentrator and Expander"

TJ 4
"Concentrator/Expander and Loop Connector"

Out at 7'12" into VT tape

So you see that this exchange although it looks very different from an automatic exchange, embodies the same functions as an automatic exchange although they're implemented just using a different technology.

Well lets turn our attention to the control again, to the operator, and look at some of the functions she's performing.

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W/T

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Operator: "Number Please"
Malcolm: "Dr. Jolly his extension is 4 something or other."
Operator: "Dr. Jolly he's on extension 46"
Malcolm: "Thank you"
Tony Jolly: "Hello, Tony Jolly"
Malcolm: "Just testing thank you very much."

V/T

Malcolm: Also the operator can provide a number of very advanced facilities requiring information storage and special translation of the address information.

Operator: "Number please"
Malcolm: "Extention 59 please"
Operator: "Oh do you want Dr. Jolly?"
Malcolm: "Y s Please"
Operator: "Oh he's in the OB unit I'll put you through now"
Malcolm: "Thank you"

Tony Jolly: "Tony Jolly"

Malcolm: "Just testing, thank you"

Malcolm: To do this sort of thing in an automatic system requires very sophisticated control equipment. And ever since automatic exchanges were introduced their designers have been striving to achieve the sort of flexibility that one gets with operator control. In public systems manual exchanges have been largely replaced by automatic ones, which achieve the speed and cheapness but sacrifices to some extent the sort of flexibility and personal service you get from the manual system. And the sort of space savings one gets with an automatic system aren't really that significant. However, in recent years with the introduction of electronics some of these drawbacks have been removed. So let's look at a prototype electronic exchange which goes some of the way to restoring the flexibility of operator service, and achieves quite significant space saving.

This part of the manual board serves about a hundred lines. So let's look

(3 NEXT)

at what the equivalent of this in an electronic exchange looks like.

Mix to /BOOM/

5. 3 A
CU of Digital Exchange

Demonstrates simple A to B call.

6. 2 A
2S Gaby + Equipment

"it's all digital"

7. 1 C
CAP. 2
Block diagram of Digital Exchange

Explains and relates to equipment.

8. 2 A
2S Gaby + Equipment

Intercut with:

3 A
CU of processor
CU of Equipment

Signalling cards and the switching network which is all on one card!

(AS DIRECTED)

Before we demonstrate some special facilities,

9. 2 A
2S Gaby + Equipment

How does it work?

(CSO)

10. 1 B /
CU of CSO Blue Board

MALCOLM: (O.O.V.)

3 A /Explains with pointer.
CAP.3
Switching Equipment for Digital Exchange

But signals are digital from telephone, so we can use digital switching as described in the course book.

/EPISCOPE SEQUENCE/
(on CSO)

11. Episcope /This is T-S-T switch as in book.
CELL 1

Explains operation.

Individual lines, as well as p.c.m. systems can be connected to this type of switching network.

12. Episcope /
CELL 2

We don't have to have this balance of time and space switching. We can go to one extreme - all space. Just like analogue switching.

13. Episcope /
CELL 3

In this case the buffers become

14. Episcope unnecessary, so we take them away./
CELL 4

But this is too expensive.

Or we can go to other extreme - all time switching.

15. Episcope /
CELL 5

This is a bit dodgy from reliability point of view, but OK for small exchanges. This is how this experimental PABX works.

16. Episcope /
CELL 6 - 8

[0] or [1] Symbols

Go through one time cycle moving magnetic "bits" around.

Well, that's switching. What about signalling?

17. 2 A /
CU of CAP. 4
Signalling Word

ZOOM OUT to Whole Cap.

These are local line signals. Every 9th bit is signalling. Eight speech words give one signalling word. This can represent call-request, digit signal, or clear.

Lets look at complete switching and signalling set up.

18. 3 A /
CAP.5
Switching Circuit for
Digital Exchange

Well, it's got the set-up we saw earlier twice: one for each direction of transmission. Hung onto the common highways are the signalling units. These are time-shared between all ongoing calls. So same time-sharing principle of T-S-T is here applied to make signalling nice and cheap.

Explains how line unit, register, and supervisory unit scan all calls. Pay special attention to how line unit manages to scan all lines by switching of signalling bits from all lines into a signalling time-slot.

So, what do we get on these highways. Well, this exchange works on bit by bit switching, so what we'll see will be:

19. 2 A /

CAP. 6
Line and Highway Signals for Digital Exchange

This shows what happens on one of the two highways with two calls taking place.

ZOOM IN to CU of Signals in Centre.

Lets look at the real thing:-

20. 3 A /

CU of CRO on Digital Exchange Equipment

Explains

21.	2 A 2S Gaby + Equipment Intercut with: 3 A CU of Equipment (AS DIRECTED)	/GABY: Well, now lets return to the processor which provides the control functions. Can be programmed to give any required facilities. For example: Demo of transfer. Demo of another facility.
22.	2 A 2S Gaby + Equipment	/So, you see how super-duper this all is. Another benefit of this sort of arrangement is that the technologies of the switching and control are the same, so there is no interface problem between them. This makes for even cheaper system. Final point: Just as there is signalling from terminal to exchange, there is also signalling exchange to terminal AND the signal alphabet is not restricted to 12 signals as with multifrequency; there can be 256 different signals; push-buttons could become a full typewriter keyboard; AND signalling can take place without interrupting speech These three things add up to full interaction between user and exchange

throughout the call or simultaneous data (graphics, text) transmission.

Example: Exchange could send user the identity of the caller BEFORE the user answers the telephone!

23. 3 A /

CU of Equipment

S/I

23A. TJ5 /

The Speakers were
Malcolm Hamer
Gaby Smol

23B. TJ6 /

Facilities
The General Electric Co. Ltd.
HIRST RESEARCH CENTRE

Plessey Telecommunications Ltd.

23C. TJ7 /

Production by
Tony Jolly

23D. TJ8 /

A Production for the
Open University BBC-TV

/FADE 3A/ /FADE SOUND/

/FADE TJ8/