

BELL TELEPHONE LABORATORIES
INCORPORATED

SUBJECT: Memorandum "Communications Equipment
for '2001!'"

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FROM: J. R. Pierce

6/25/65
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Recently Arthur C. Clarke (author of VOICE ACROSS THE SEA and many other nice books) and Frederick I. Ordway, III, scientific consultant of Polaris Productions, Inc., saw me to enlist my and the Bell Laboratories' help concerning simulated communication equipment for a very lush science fiction picture which Polaris is making and MGM releasing in color and Cinerama. I agreed because I'd rather have us than General Telephone or someone else exercise what influence can be exercised. I'd even like a Blue Bell on the telephone booth. Further, I may be able to get in a few plugs about voice plus data.

In making the picture, Polaris Productions is working very closely with NASA headquarters and the many field centers as well as with universities, research institutes and industrial concerns throughout the country. Among the industrial concerns mentioned were: Whirlpool, which is preparing a 21st century space kitchen, and IBM, which is designing the facade and functions of a computer for the spaceship. GE was also mentioned; I do not know what they are doing.

Polaris is quite willing to acknowledge advice received from Bell in the picture. Ordinarily we'd steer clear of this for fear of misrepresentation. I don't see how we can be misrepresented in a scene dated 2001. No one can check up until then, and by 2001 the picture will have been forgotten. The question of such screen credit can be faced later.

The attached pink is my first version of what I think Polaris needs. I'd appreciate any comments.

J. R. Pierce
J. R. PIERCE

Att.
Draft "Communications Equipment
for '2001!'", dated June 25, 1965

COMMUNICATION EQUIPMENT FOR "2001"

This memorandum is concerned with simulated communication equipment for a forthcoming MGM picture written by Arthur C. Clarke, to be directed and produced by Stanley Kubrick. The picture is being made by Polaris Productions, Inc. and will be released and distributed by MGM, hopefully by the end of 1966. The title of the picture is "2001: A Space Odyssey." The picture will be released in Cinerama and color.

The picture deals with a flight to Jupiter. During the flight, a failure of communications occurs through damage to the microwave antenna on the space vehicle.

This memorandum addresses itself to two problems:

1. The communications center of the spaceship, and communication between the spaceship and an earth, satellite or moon base.
2. Domestic telephone service, as exemplified by routine phone booth service between an orbiting space station and earth.

In both cases it is assumed that one communications circuit will handle voice, picture, and data service. Each terminal must be provided with a microphone and speaker (a telephone handset can be provided for optional use to insure some privacy or protection against noise); with one or more screens on which television pictures or data can be displayed; with a keyboard, either a small keyboard such as

that used in touch-tone dialing, or a full keyboard for data; with a slot from which messages can emerge, (messages will also be displayed on the television screen); and with a number of special-purpose controls. These controls will in many cases be illuminated oblongs with some such label as "computer" or "acknowledge." When the user presses one of these, the color of the light illuminating the oblong will change until the operation signalled has been completed.

1. The Communications Center of the Ship

A few simple calculations show that with a large antenna on earth it would take only a very weak transmitter power to communicate from the ship to the earth. The plot depends on breaking of communications from ship to earth, while there is still communication from earth to ship. We just have to acknowledge to ourselves that though this is a contingency required by the plot, it is technologically unsound.

I believe that a part of the communication between the ship and the earth should be a weak pilot signal which is on at all times. This provides a simple means for the base station to track the ship, and to know that all is well on the ship. This pilot channel can be used for a slow routine data report on the vital functions of the ship. Thus, even if the crew of the ship do not notice that something has gone wrong, the base station will find out if anything critical goes wrong and will be able to inform the crew.

The pilot signal and slow data link from the ship to the earth can also be helpful plotwise. When the large microwave antenna on the ship is destroyed so that the pilot channel from ship to earth is permanently disabled, the absence of signal will be noted immediately on earth. Thus we can have a scene of consternation and efforts to raise the ship which will be more effective than inability to make contact with the ship at some routine message time.

It might also be worthwhile to have a continuous pilot signal from earth to ship. This could be used in keeping the ship's antenna permanently pointed. It could be used for sending routine data, such as that necessary for reproduction of the New York Times or some other newspaper aboard the ship. It would be more economical to send such data over a long period of time than rapidly and intermittently.

I think it is also important to have some periodic routine contact between the ship and the earth, say, once or twice a day. This cannot involve a telephone conversation as we know it, because the transmission time is too great. Transmission time can easily be computed by dividing the distance between ship and earth by the velocity of light. It is important to note what the transmission time is and to make the picture consistent with this.

I do think that it is important to use some sort of voice signal. This will have to be a sort of spoken note memorandum or telegram, or rather, a sequence of such notes,

instead of the give-and-take characteristic of a telephone conversation. The writer should imagine himself in the position of writing, say, an exchange of brief and informal telegrams.

We now come to the communication equipment aboard the ship, and to its use during a routine contact.

I think of the following as the essentials of the communications center on the ship. Above and in the center, at eye level, we have a TV screen used in person-to-person transmission. This will show either one's own face, the face of the person to whom one is talking, or data when data is being transmitted or received. To the left and to the right we have alternate screens for transmission of scenes from the ship. These might be two exterior cameras, or they might show other scenes interior to a ship, including equipment or instruments. More screens can be used if desired. Below each of the screens there is a lighted and labeled oblong for activating that particular screen.

It might be desirable to show TV pictures as a sequence of frames transmitted perhaps twice a second. This will recall the "movies" taken of the spacewalk from Gemini, which were shown on TV screens all over this country.

There might be a handset available someplace, as has been noted.

Lower, there should be a full keyboard arranged for convenient use. This would be the equivalent of a typewriter keyboard. I don't think that we should have a conventional typewriter, however. Rather, we should have a slot for outgoing messages. Messages that are typed on the keyboard will appear on the TV screen prior to transmission. They can be viewed for editing, edited by means of the keyboard if necessary, and then transmitted by pressing a proper oblong either under the TV screen or next to the keyboard.

There should also be a slot for messages transmitted and received. When a message is finally transmitted, a printed copy for reference comes out of the slot. When a message is received, a printed copy comes out. This may be anachronistic, but I think it is probably worthwhile.

Besides the keyboard for special purposes, and for computer input, there should be a number of oblongs with various labels. By pressing these, the operator can transmit data of various sorts to earth. There should certainly be an oblong for "computer", perhaps oblongs for "life support" (which will transmit back various biological readings and the condition of the atmosphere in the ship, and perhaps the temperature), "radiation," "propulsion," "navigation." Here I am dealing only with the communication problem. Somebody else will have to think up how many different things should be reported from the ship on demand. At any time during a

routine communication, a crew member can report back appropriate data by pressing one of these oblongs. The data will appear momentarily on the TV screen. Then the light under the oblong will change color, from green to yellow, until transmission has been completed, when it will revert to green. A red light will indicate malfunction.

What will a routine call be like? Suppose it comes in from earth. A light should flash in the communications center. There should also be an audible signal, in case a crew member is not at the center. This might be "Hear this message, hear this message. Transmission in 20 seconds." Then there will be a routine transmission in 20 seconds (or some other time, as may be chosen). On receiving this message, the crew member should immediately push an acknowledge button, so that the earth station will know whether to continue as soon as possible.

Following the specified elapsed time, there should be a message heading. This should appear on the TV screen in print as it is being read out. It should be very dry and formal, for instance, "Transmission number 147 from base to ship, time 21 minutes, 18 hours, 3rd day, 2nd month, 1970, Major Joe Glontz to communications officer, hear and record this message." This formal heading is produced automatically at the base station - it should be monotonous and a little mechanical. At the end of this formal heading, the face of

the base communicator should appear on the TV screen and he should deliver a very informal little telegraph-like message together with some chit-chat. At the end he should say "acknowledge" and his face should go off the screen.

Following this, the operator aboard the ship presses a "message" button, which sends out both in data and voice form a similar routine heading which has been stored on tape, the message number, time and date being automatically provided. Following this, the operator aboard the ship delivers a chatty little memo, seeing himself on the TV screen as he speaks. He then says that, we have this and that interesting to report, and pushes a few assorted oblongs or types something on the keyboard. If he presses the "computer" oblong, for instance, the message center accordingly sends a computer readout, or a computer program, which appears on the TV screen while it is being transmitted. This can go directly to the computer at the base station. Then the man might push the "propulsion" or "life support" oblong or might push one of the alternate "view" oblongs and send a picture from the spaceship. At the end, he again pushes another oblong which causes a message to go out in data and voice, "Spaceship so-and-so, over" or "Spaceship so-and-so, over and out," as the case may be.

There should be nonroutine messages also. These should also have an automatically-transmitted head, similar to the routine head except the message should be identified as

"Special message" instead of "Routine message." Everything else will be much the same except the attitude and language of the operator. Here he will not be kidding or transmitting routine information. He will really have something to say. Thus, his voice will be more terse, his choice of words will be more precise, and in a special message, he is more likely to have occasion to key a message on the keyboard. Routine messages are more likely to be taken care of by the built-in functions.

At the end of a message, hard copies should come out of the data slots at both ends.

2. The Phone Booth on the Orbiting Space Station

The phone booth on the orbiting space station should look simple, pleasing, and functional. I wonder whether or not it should have a door. The advantage of having a door is that one can then assert that the phone booth is completely soundproof, so that one can effectively use some sort of a secrecy device. I think that secrecy in telephone communication will be important in the future, and it might be nice to find some occasion for inserting it in the picture.

The equipment in the phone booth will of course include concealed loudspeakers and microphone, a television screen both for viewing the distant talker and for showing data, a keyboard, perhaps merely a 10-button keyboard as in touch-tone dialing, for data input, several lighted oblongs

for various special functions, and a slot for data output. If there is no door on the phone booth, a handset will be provided for communication under noisy conditions or for achieving some degree of privacy. There will also be a slot for the insertion of the user's credit card. This credit card will presumably have several key numbers magnetically recorded on it - different numbers for different purposes.

Let us first consider the matter of secrecy. Secrecy will be achieved by inserting the credit card and pushing a marked oblong. The credit card will have a code corresponding to the code used at the other end of the circuit. The number will be changed periodically. Secrecy will be provided between users, each pair or set of users having a common private code. If privacy as opposed to secrecy is desired, another button can be pushed, and without use of a recorded code on the credit card, something less secure than secrecy will be provided by encoding according to a code chosen automatically for each particular call by the telephone company.

I describe below two different calls. One is a call from a user on the space station to a bank. This will demonstrate certain equipment that the bank will use as well as the facilities provided by the telephone company. The other is a call from the user in the telephone booth to his own office. This will involve some equipment in the office as well as equipment supplied directly by the telephone

company. If one wishes, one can imagine a call from one phone booth to another. In this case some of the features of communication that are supplied for the purposes of the bank or the purposes of the office would simply be deleted.

Let us suppose that the user inserts his credit card into the slot in order to pay for the call and dials the number of his bank. The TV screen lights up and the user sees a small directory of various services such as "loans", "savings", "checking accounts" and perhaps others. Each of these has following it a short number, two or three digits. The user then dials the number corresponding to the service he wishes to use, which we will assume in this case is the use of a checking account.

As soon as the user dials the checking account service number, the image of a charming young lady sitting at a desk appears on the screen. She directs him in further details of the transaction. She should look just as real as life, but at some time during the call, we should see her from behind. She'll be discovered to be merely a hollow simulacrum with actuating motors and controls (should she be merely a film?). As soon as the young lady appears, she says, "Good morning, what can I do for you?". The user says, "I wish to deposit a check for \$1000 to the credit of Miss Jane Wyle." The young lady says, "Please speak your name distinctly for voiceprint identification." The user speaks

his name; she says the identification is proper. "Will you please key the person's identification number and the amount of the check?" As the user punches these numbers by means of the keyboard, the image of a check appears on the screen, with the numbers in the payee and amounts columns. The user's own identification number also appears; this has been obtained from the credit card which is in the telephone slot. The young lady's voice says, "If that is correct, please press the acknowledge button." The user does this, the young lady appears and says, "The transaction has been completed, thank you." A record of the transaction comes out of the message slot.

We should also provide a disposal unit for such records if the user doesn't want to keep them.

If, during this transaction, the user does not know Miss Wyle's identification number, or if his identification by voiceprint is in doubt (or for other plausible reasons), the young lady appears and says, "I will have to connect you with my supervisor." Then the user talks via telephone and television with a real person, who has at her command various bank records that can be summoned up by means of a keyboard.

We will now consider a call which the user makes to his office after business hours, to leave a typed message to be delivered to or forwarded to someone. He dials the number of the office. He hears an answering voice and sees an

abbreviated directory. In this case, however, he knows the number he wants to dial, which is the number of a secretarial machine in his own office. He gets this machine and the television screen shows on the screen a legend, "Secretarial machine, office of Mr. A. B. Brown. Will you please repeat the following sentence for voice calibration - 'The quick brown fox jumps over the lazy dog.'" (This should be replaced by a sentence containing all phonemes.) The reason for using this sentence is that it contains all the phonemes of English. The user repeats the sentence and the television screen shows the word, "Ready." The user then dictates the letter slowly and distinctly. As he dictates, the letter appears in typewritten form on the television screen. Occasionally, the machine will make an error, or will not know how to spell a name, or will be unable to distinguish between "two" and "too." Either a question mark will appear, showing that the machine is undecided, or else the user will notice the misspelling. In either case, he will push a button, perhaps the zero button on the keyboard. As he pushes the button repeatedly, words will disappear. When he has obliterated the error, the user will spell out the word in question and the machine will type it out letter by letter. In the course of dictating the letter, capitalization and punctuation will be required. I think the best way to handle this is to have the user push various buttons which have been assigned for these duties. After the

letter has been completed, the user will push a button or oblong. The letter will disappear from the television screen and a copy will come out of the slot for the use of the user. The screen will then show "Operation Completed." It might also say, "If you wish this message certified, please speak your name for voiceprint identification." The user can then either speak his name or sign off without speaking his name.

J. R. Pierce
June 25, 1965