Virtual E.R.N.I.E

Electronic Random Number Indicator Equipment

An online simulation of the ERNIE, the National Savings and Investments built by the General Post Office Research Station at Dollis Hill in 1956
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Getting started

This tutorial will guide you through getting Virtual ERNIE started and get you to resolve a few issues that the original operators may have had to deal with while he was running.

To view more of ERNIE, click the left mouse button and drag on the background. If you have a touch screen, just use your finger to scroll around as normal.

To zoom, use the mouse wheel or alternatively, use the zoom level buttons on the control panel in the top left of the screen.

To change switches, click or touch the top of the switch to move it upwards and the bottom of the switch to move it downwards. Open racks or drawers by clicking on the handles.

Clicking on an info button will give you detail or photos on each section to tell you how it worked or how to use it.

Show or hide the main console if you need to see behind it

Choose to view the front or rear of ERNIE by changing this switch

Zoom in to see closer or out to get an overview

Show or hide the spur teleprinters (SPU)

Show or hide the help dialog

▶ **Try zooming in/out, moving around and then click/tap on the rack doors and drawers on ERNIE to see what's inside.**

▶ **Click on the info button marked "What is E.R.N.I.E" at the top left of the racks. This gives an overview and demonstration of what ERNIE is doing and how he generates random numbers. When you've done, click the white cross in the red circle in the top right to close it.**

Let's get ERNIE working

ERNIE is all powered up and ready to begin. Below is the main console that was used to start and stop the draw and to keep a check on any problems.
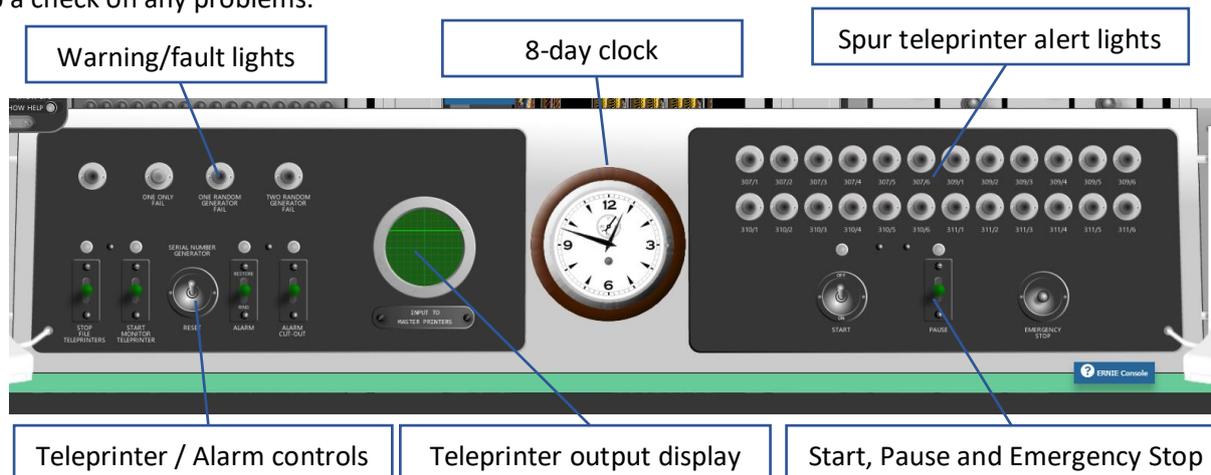
You can find out more about all the controls later by clicking on the blue info button marked "ERNIE console" but for the moment, a couple of useful keys to know about are the ones marked "ALARM" and "ALARM CUT-OUT". These are useful in case you set off the alarm (for example by switching off a power supply) so you know where to come to stop it! Setting the "ALARM" key down will immediately set off the alarm bell while moving it up to restore will stop it (although if you still have an issue, the bell may well immediately restart!). The "Alarm Cut-Out" key can be set down to disable any alarm bells completely (this is the key set by the mute icon that appears on screen if you want to un-mute).

Another important note - *don't* press it now, but if you accidentally press the "EMERGENCY STOP" button, ERNIE will immediately power down! To get him running, you'll have to find the power breakers on the second rack in from the left on the rear of ERNIE.

▶ **When you are ready click/tap on the START switch to set it to ON.**

You should hear ERNIE start printing and the display will show the printer output signals being generated.

What is ERNIE printing?

On the far left and right of the main console desk are the two main teleprinters which output the randomly generated bond numbers that ERNIE is dreaming up. A bond serial number consists of nine digits followed by an incrementing serial number.

▶ **Move/zoom to the left hand teleprinter to watch the numbers being printed.**

Note from Virtual Colossus: Some browsers are better than others at showing tiny text which has been rotated in real-time (Firefox is particularly bad at this!). If you're seeing the numbers blurred, try pressing the green key marked "Start Monitor Teleprinter" down. This will place another teleprinter on the desk which was used for testing purposes but it's also easier to see the numbers being printed!

The first number shows the 10 million digit then two letters, the first of which shows the value of the bond (A is a £1 bond, B is a £2 bond and so on down to Z for a £500 bond) and the second letter is a defined list of letters which shows the millions digit. Finally, there are six further digits showing the 100,000 values. An example bond number of 2AS 123456 is bond number 27,123,456 with a value of A (£1).

The final four numbers are the serial number. This is an incrementing number generated by ERNIE so it was known which order the bonds were printed. The first numbers picked getting the largest prizes!

How does ERNIE think of a number?

The front racks are numbered from 5 on the left down to 1 on the right. Front rack number 2 (the second from the right) holds the random noise generators which generate the random data used to pick the numbers during a draw. Rack 3 in the centre holds several printed circuit boards for the counters, combiners and stores (this is one of the first uses of printed circuit boards by the GPO and used the newer transistor and ferrite core technology rather than electronic valves (vacuum tubes).

▶ **Open the doors of rack 3 and rack 2 by clicking/tapping on the handle.**

It uses the noise created in a cold-cathode gas diode. This noise is amplified and when the level peaks above a pre-set value it generates a pulse which is passed on to a counter in rack 3. Each counter uses the results of two separate random generators to make sure that a single faulty generator cannot influence a random output.

ERNIE has a total of twelve pairs of random number generators (RNG) - ten of these are in use when running with two spare sets which can be swapped in if required.

Every 1/6th of a second, the results of the nine counters are read into the stores and used to represent each of the values within a bond number.

As two different random generators are used for each number, ERNIE can cope with a failure of any single random number generator and still generate new bond numbers. To demonstrate this, you should see a small button in the top left (a spanner/wrench) which can be used to set a fault on one or more of the generators.

▶ **Click/tap on the wrench/spanner icon and choose a Set fault->RNG*[#]* option.**

You should see the faulty generator lights up a warning cold-cathode bulb plus the "One random generator fail" light on the console will light. ERNIE should continue as normal!

▶ **Set another fault on a second RNG.**

ERNIE will now pause, and an alarm will sound along with the "Two random generator fail" light on the console! To fix this, you'll need to clear at least one of the faulty generators (use the icon again) and then click on the "alarm reset" button (which is to the middle/right of rack 2) or set the "Alarm" key on the main console up to "restore" which will clear the errors.

What happened if ERNIE went wrong?

ERNIE was built with nearly all components having at least one spare ready to swap over should the worst happen, a good example of this is the power supply units.

In rack 1 (on the far right) are the -150v power supplies for the random generators along with a separate one marked as spare. To find out what happened when ERNIE had a component fail, let's see what happens if we switch off some of his power!

▶ **Choose one of the two top power supplies (marked 6 or 7) and tap on the mains switch at the bottom centre of the panel.**

As soon as ERNIE notices that some of his random generators have gone off line, an alarm bell is activated to notify the operator (and everyone else) that something has gone wrong!

▶ **It's a little noisy now, so click the Mute button that has appeared or find the "Alarm Cut-Out" key on the main console and switch it down to cut off the alarm.**

To fix this problem, we simply need to swap over to the spare power supply and switch it on.

▶ **Click on the black cable connected to the power supply you just switched off, just where it goes into the power supply, this will switch the cable to the spare. Finally, tap on the mains switch on the spare supply to power it up.**

ERNIE is now ready to run again! The faulty power supply could be removed and taken to be repaired or replaced.

To check ERNIE is all working, find the main console desk and click the "Pause" switch down then back up to the centre position so ERNIE can continue printing. Lastly, on the left-hand console is the "Alarm Cut-Out" key which, if you muted the alarm, will be in the lower position. Tap the top of the switch to move up to its central position to reset the alarm for next time. Good work!

What happens to the generated numbers next?

The numbers that ERNIE generates are automatically printed onto one of eleven pairs of teleprinters, depending on their denomination letter, within the numerical filing rooms. All the bonds sent in are prepared onto filing cards, photocopied and stored in a huge filing system (at the time, the largest of its kind in Europe!). As the numbers were printed, people would be sent out to check in the files that the number is a valid, sold bond and who the lucky winner was.

The remote teleprinters were known as the spur or file printers (SPU for short). Virtual ERNIE has the option to view these printers.

▶ **Tap the switch marked "Show/Hide SPU" on the switch panel in the top left of the screen.**

There were two printers for each spur position: a page printer for a full copy of all relevant numbers and one which prints onto 3/8" wide gummed paper to stick onto the guide cards. You should be able to see these printing as ERNIE generates numbers for this spur position.

▶ **Tap the buttons below the spur position to see each of the different denominations being printed.**

If there was a problem, for example the printer jamming, it was necessary to notify the draw operator at the main console that there was a problem. To achieve this, a switch was also available at each spur to do just that.

▶ **Tap at the bottom of the left hand green key marked "Call" to set it down.**

If you look at the right-hand section of the main ERNIE console, you should see a red warning light now showing. The number against the light was the internal phone extension number so the operator could use the right-hand telephone provided to call up and check what the problem was.

▶ **Set ERNIE to pause - press at the bottom of the green key marked "Pause" just under the warning lights.**

When ERNIE was in pause mode, a light on top of each spur control panel lit up to show that there was an issue. Once the problem was resolved, the call key and pause key would be reset back to the centre to continue the draw.

▶ **Press at the top of the green key marked "Pause" and also on "Call" to continue printing.**

What's round the back?

ERNIE was built with standard GPO racks with five racks across and two deep. Viewing the rear racks on the real ERNIE meant squeezing down between the wall and the rear racks, but Virtual ERNIE can bring it to you!

▶ **Press the left-hand switch on the control panel at the top-left of the screen marked "Show Back". Try opening all the cabinet racks by tapping on the door handles to see what's inside.**

Checking the power

Rear Rack 2 holds the power distribution and fuses. Let's check our power supplies are set correctly.

▶ **Tap on the large grey dial next to the meter. Each tap will rotate to the next setting**

Each setting shows the power output of one of the 18 power supplies which could be manually adjusted on the power supply control panel.

The redundancy Table

The first draw held in June 1957, included a total of 48.4 million bond units but ERNIE could choose from a total of 720 million numbers! How did they manage, in the mid-1950s (without hard-disks and databases), to stop most numbers that ERNIE generated being from unsold bonds?

The answer is the redundancy table which can be found inside rear rack 3. It worked by splitting up the first four digits of the generated bond number and checking them each separately, deciding if the number was invalid and if so, ERNIE would delete it from his store and find a new one.

Each month, before the draw, a list of the highest bond number sold for each of the denominations were drawn up. This was then used to work out a sequence of transistors which were hard-wired into the redundancy table in sections for each of the digits being searched (the yellow and green components on the grey boards are the transistors). Each transistor can be inserted and wired in various configurations or removed on Virtual ERNIE by clicking on them to simulate setting up an actual draw.

Section 1 is checking the 10 million bond digit of the number just generated with the denomination to see if it's a valid number, an unsold bond (redundant) or needs further checks. The two boards on the top left-hand side of the redundancy table marked with columns 0-5 and rows A-K on the top board and L-Z on the lower one is section 1.

▶   **Click on one of the transistors in section 1. Each click changes between options for the transistor wired for redundancy, to pass to the next section, for special wiring or not inserted. You can also right-click (or long hold) for a menu if you prefer.**
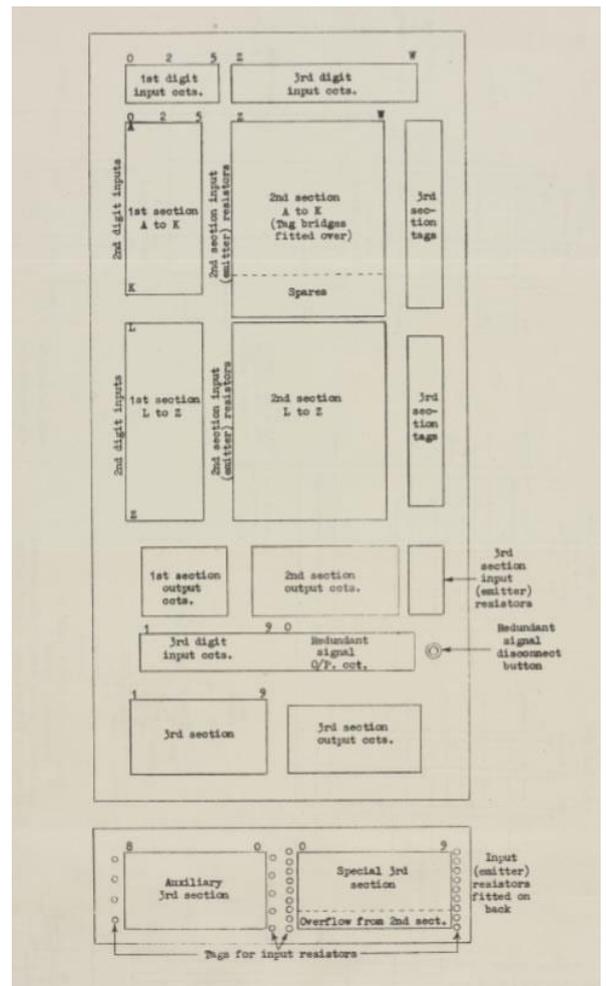
To enable more wiring options on section 2 (the top-right board), a series of removable bridges were attached which are shown hiding the transistors below.

▶   **To view and change the transistors for section 2, click on the eye icon to hide/show the bridges.**

Section 2 transistors have more options for connection as well as the ones available on section 1, they are checking the result from section 1 with the 1 million digit. The connections include wiring to section 3, to the auxiliary table and to the special table. The standard connection to section 3 is wired by connecting to tags made available on the far right. Each row can be connected to one of nine tags which are extended down to the hard-wired boards below.

▶   **Change each row's wiring to section 3 by clicking on the tag board on the far right adjacent to the row. Each click will move the wiring on one position.**

Layout of redundancy table Ref: EX 29985, Research Report No. 14221 - E.R.N.I.E. Design of Redundancy Table. - image © BT Heritage

To find out more about how the redundancy table worked and how it was changed, click on the blue info button.

Finally

Head back around to the front of ERNIE and you should hopefully see he's been busy printing off lots of random numbers for you.

▶ **Press the left-hand switch on the control panel at the top-left of the screen marked "Show Front".**

ERNIE was stopped by first pausing the generation of numbers before finally stopping the draw. This was to make sure that the final number was printed out in full and not cut of half-way through.

▶ **Click on the lower part of the "PAUSE" key on the main console and wait until printing stops. Now click on the "START" switch to set back to off and last of all, set "PAUSE" back to the centre position.**

You should now get a display giving some statistics on how many numbers Virtual ERNIE has printed. He's not very fast by todays standards but in the mid-1950s, he was cutting-edge.

To find out more about ERNIE, try reading the info boxes for all the panels which give more detail on how each part worked. If you want to view a promotional video made by the GPO in 1964 which will show you a lot about how ERNIE was run, try clicking on the left-hand drawer of the main console. If you want to read more detail and get further technical information, a few of the original manuals (in PDF format) are available for you to download and view in the right-hand drawer.

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