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EXPONENT

Mathematical equations can often become extremely complicated, so long arithmetical expressions are written in a simplified type of shorthand whenever possible. One convention for shortening lengthy, repetitive multiplications is to use an *exponent.* For example, look at the expression:

$$7\times7\times7\times7\times7 = 16{,}807$$

What the expression indicates is 'seven multiplied by seven a total of five times'. By using an exponent, written as a small numeral above and to the right of the number being multiplied, we can simplify this expression thus:

$$7\times7\times7\times7\times7 = 7^5 = 16{,}807$$

The numeral 5 is called the exponent or index, and 7 the base or mantissa. The shortened expression means the same as the longer version, but occupies much less space and can make arithmetic simpler. In multiplication, for example, the product of numbers with like bases is formed from the sum of the exponents: $49\times343 = 7^2\times7^3 = 7^5 = 16{,}807$.

FACSIMILE TRANSMISSION

The transmission of documents or images from one location to another is essential to the operation of the electronic office. Machines to carry out this task have been available for many years, but early *facsimile transmission* (also known as 'fax') was dependent on analogue electronics. Using this system, the piece of paper containing the image to be transmitted was taped to a rotating drum and scanned by a photocell — a process taking about five minutes to cover an A4 sheet. Electronic signals representing the image were then transmitted via the telephone network to the receiving station, where a similar rotating drum was used to convert the signals back into an image by using heat-sensitive printing. Newer systems use lasers to scan the document to be sent and employ digital techniques to transmit the data to the receiving station, where a laser printer produces a high-quality copy.

FACTORIAL

The *factorial* of a positive integer number is the product of all the integers from one to the specified number. The shorthand symbol for factorial is an exclamation mark following the number. For example:

$1! = 1$
$2! = 1\times2 = 2$
$3! = 1\times2\times3 = 6$
$4! = 1\times2\times3\times4 = 24$

It is seen most often with the combination and permutation operators, thus:

$${}^{n}C_{r} = \frac{n!}{(n-r)!\,r!} \quad \text{and} \quad {}^{n}P_{r} = \frac{n!}{(n-r)!}$$

gives the number of ways of combining and permutating r things from n. For example, the number of possible five-card hands in a pack of 52 is ${}^{52}C_5$, and the number of ways of laying those hands out in order is ${}^{52}P_5$.

FAIL-SAFE

Computers designed for sensitive or dangerous applications — for example, the control of fuel rods in a nuclear power station — are designed to be *fail-safe.* This simply means that a fault in the system will not cause a fatal error. In practice, it is not possible to guard against all possible faults, but the use of back-up systems and safety procedures can ensure that any malfunction has a minimal effect on the overall system.

An example of a fail-safe system is the 'dead man's handle' used on some trains. This requires pressure to be applied to a lever at all times: if this pressure is relaxed, power is shut off and the brakes are applied automatically.

FAN-IN

A *fan-in* is the number of input lines used in a logic gate or a logic device.

FAN-OUT

A *fan-out* indicates the maximum number of output devices that can be safely driven by a logic gate. If the number of output devices attached to a logic gate exceeds the device's fan-out, the difference between the voltage levels that correspond to logical 1 and logical 0 is decreased. This makes it more likely for errors to occur in the operation of the logic gate.

FEEDBACK

Feedback is information taken into a control device from an external source, and is used by the system to determine the next action that needs to be taken. A simple example is a thermostat that controls the temperature in a house. The thermostat reads the temperature around it and activates the heating system when the temperature reaches a minimum point, or turns the system off when the system reaches a maximum point. Feedback can be used in control projects with microcomputers by having an analogue-to-digital convertor connected to an external sensor.